Association for Cognitive Science

1st Annual Conference on Cognitive Science
3rd – 5th March 2014, New Delhi.

(Abstracts)

ORAL PRESENTATIONS

Day 1: 3rd March, 2014 (Monday)

08:00 - 09:00 **Registration**

09:15 - 09:45 **Inauguration**

PLENARY TALK

10:00 - 10:40 Towards a cognitive neuroscience of individual differences: Genes, brain, and behavior, **Chandan Vaidya**

Session I: Functional Neuroimaging (10:40 – 11:40)

10:40 - 11:00 Neural Loss aversion differences in Healthy and Depression individuals: A functional MRI Investigation, P.G. Rajesh, C Kesavadas, **V. S. Chandrasekhar Pammi**, P. R. Mary, S Seema, Ashalatha Radhakrishnan and Ranganatha Sitaram.

11:00 - 11:20 Structural and Functional networks underlying auditory processing in children with autism, **Megha Sharda** and Nandini C Singh

11:20 - 11:40 Effect of COMT, 5-HT2A and 5-HTTLPR polymorphisms on brain morphometry in schizophrenia and healthy subjects, **Anupa A.V**, John P John, Harsha N Halahalli, Bhavani Shankara Bagepally, Pradip Paul, Priyadarshini T, Nagaraj S. Moily, Meera Purushottam, Sanjeev Jain and Vikram Arunachalam

11:40 - 12:00 COFFEE BREAK

PLENARY TALK

12:00 - 12:40 Three key factors in human cognitive evolution, **Jordan Zlatev**

12:40 - 13:30 LUNCH

POSTER SESSION I: (13:30- 15:00)

Session 2: Language and Cognition (15:00 – 16:50)

15:00 - 15:20 Similarities and Differences in Thai and Telugu Motion Event Descriptions, Jordan Zlatev, Viswanatha Naidu, **Vasanta Duggirala.**

15:20 - 15:40 Aspects of the Hindi Compound Verb, **Samiksha Bajpai** and Rajesh Kasturirangan.

15:40 - 16:00	Cognition and semantic language perception in early blind and late blind subjects, **Ankeeta Sharma**, S. Senthil Kumaran, Vaishna Narang and Rohit Saxena.
16:00 - 16:20	Semiotics, names and the titular projection, **Probal Dasgupta.**
16.20 – 16.40	**COFFEE BREAK**

Session 3: Reading or Language Processing (16:40- 17:50)

16:40 - 17:10	The relationship between auditory rhythm processing and language and literacy skills in the early-adolescent brain, **Manon Grube**
17:10 - 17:30	Group differences for Rotation Related Negativity (RRN) while Reading, **Gunjan Khera** and Thomas Lachmann
17:30 - 17:50	Perceptual Span of Readers of Hindi in Devanagari, **Maranatha Wahlang**, Kiran Kishore, Gautam Sengupta.

Day 2: 4th March, 2014 (Tuesday)

Session 4: Motor Learning (9:30 – 10:40)

9:30 - 10:00	What is the role of the motor system during action understanding? **Angelika Lignau**
10:00 - 10:20	Motor Adaptation Deficits in Ideomotor Apraxia, **Pratik Mutha**, Lee Stapp, Robert Sainburg and Kathleen Haaland.
10:20 - 10:40	A dedicated common network underlies the initiation of eye and hand effectors during a coordinated movement, **Atul Gopal** and Aditya Murthy.

PLENARY TALK

10:40 - 11:20	Cognitive Sciences: A Military Psychology Perspective, **Manas Mandal**
11:20 - 11:40	**COFFEE BREAK**

Session 5: Visual Processing (11.40 - 12:40)

11:40 - 12:00	The influence of spatial cueing on serial order visual memory, **Rakesh Sengupta**, Prajit Basu, David Melcher and Bapiraju Surampudi
12:00 - 12:20	Conscious Recognition of Neuro-Feedback, **Nishant Seth**, Anirudh Wodeyar and Rajesh Kasturirangan.
12:20 - 12:40	Dynamical control of Hierarchical Stimuli, **Devpriya Kumar** and Narayanan Srinivasan
12.40 - 13.30	**LUNCH**

POSTER SESSION II: (13:30 – 15:00)

PLENARY TALK

15:00 – 15:40	Distinguishing conceptual from motor decisions, **Jens Schwarzbach**
15.40 – 16:00	**COFFEE BREAK**

Session 6: Computational Modelling (16:00 - 17:50)

16:00 - 16:30	The single neuron and prediction errors, **Biswa Sengupta**
16:30 - 16:50	A computational model of dopamine-serotonin modulation in Basal Ganglia: Towards understanding the cognitive deficits in Parkinson's Disease patients, **Pragathi Priyadharsini Balasubramani**, Srinivasa Chakravarthy V, Ravindran Balaraman, Ahmed Moustafa.
16.50 – 17.10	Role of STN-GPe in decision making- a 2D spiking neural network model, **Alekhya Mandali**, Srinivasa Chakravarthy
17:10 - 17:30	Modeling Choices at the Individual Level in Decisions from Information Search, **Neha Sharma** and Varun Dutt.
17:30 - 17:50	Social influence on evolution of cooperation, **Balaraju Battu**, V. S. Chandrasekhar Pammi and Narayanan Srinivasan
17.50 – 18.30	**ACS GENERAL BODY MEETING**

Day 3: 5th March, 2014 (Wednesday)

Session 7: Emotion Processing (9:00 -10:30)

09:00 - 09:30 Global-local processing is influenced by irrelevant emotional processing: An ERP study using an odd ball paradigm,
Narayanan Srinivasan and Shashikanta Tarai.

09:30 - 09:50 The perception of emotion in Eastern music - A study on North Indian Classical Ragas,
Avantika Mathur and Nandini C. Singh.

09:50 - 10:10 Scope of Attention Modulates Outcome Processing in Decision Making under Risk: An ERP Investigation on Medial Frontal Negativity,
D**ebarati Bandyopadhyay,** Narayanan Srinivasan and V. S. Chandrasekhar Pammi.

10:10 - 10:30 ERP correlates of task relevant affective conflict monitoring and adaptation,
Bhoomika Kar, Narayanan Srinivasan, and Richa Nigam.

10:30 - 11:00 COFFEE BREAK

Session 8: Multilingualism (11:00- 12:20)

11:00 - 11:20 Effect of Proficiency on the proactive control mechanisms among Hindi-English bilinguals ,
Jay Prakash Singh and Bhoomika R. Kar.

11.20 - 11.40 Effect of Language Proficiency on the Processing Cost associated with Language Switching,
Khushboo A. K. Mishra, Hari S. Asthana, Indramani L. Singh.

11:40 - 12:00 Neural correlates of language proficiency in trilinguals- an fMRI study,
Keerthi Ramanujan, Shweta Soni and Nandini Chatterjee Singh

12:00 - 12:20 Body parts and Early-learned Verbs in 4-year-old Telugu speakers: A cross-linguistic comparison in association,
Madhavi Latha Maganti, Joshita Maouene and Bapi Raju Surampudi.

12:20 - 12:40 Performance Monitoring and Response Inhibition in a Saccadic Countermanding Task in High and Low proficient bilinguals,
Niharika Singh and Ramesh Mishra.

12.40 - 13.30 LUNCH

Session 9: Social Cognition (13:30 – 14.50)

13:30 - 13:50	Cognition and Culture: Testing semantic memories in Indian patients, **Gowri Iyer**, Shailaja Mekala, Divya Raj, Swati Karamchedu, Arun Pullela, Suvarna Alladi and Subhash Kaul.
13:50 - 14:10	Right hemispheric activity in the Iowa Gambling Task: Hyposensitivity to rewards, hypersensitivity to punishment, or regulatory control? **Varsha Singh.**
14:10 - 14:30	'Left eye - right brain': Exploring the impact of social isolation on personality traits and lateralized utilisation of the brain in an air-breathing freshwater fish, climbing perch, **VV Binoy** and Anindya Sinha.
14:30 - 14:50	The effect of i-extract treatment on activity regulated gene (Arg3.1) expression and behavioural consequences in scopolamine-induced amnesic mice, **Akash Gautam**, Renu Wadhwa and Mahendra Thakur

PLENARY TALK

14:50 - 15:30	Language, Culture and Cognitive Disorders, **Suvarna Alladi**
15:30 - 15:45	**CLOSING REMARKS**

(Plenary Talk)
Towards a Cognitive Neuroscience of Individual Differences

Chandan Vaidya,
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Genetic polymorphisms of dopamine and serotonin genes have been implicated in susceptibility to psychiatric conditions. Those genes are also associated with individual variability in behavioral dimensions such as attention and emotional reactivity, among healthy people. Examining the neural basis of those genetic differences in healthy cognition provides clues to what might make some people more susceptible to a particular psychiatric condition. I will present our studies in healthy children and adults examining the role of the dopamine transporter genotype and the serotonin transporter genotype in differences in performance (e.g., working memory, logical reasoning), behavioral traits (e.g., inattention/impulsivity, anxiety), and brain structure and function (activation and connectivity). Across studies, our findings indicate that inheriting the 10/10 allele of the dopamine transporter genotype is associated with a smaller caudate, weaker frontal-striatal function, and reduced working memory. Further, inheriting the short allele of the serotonin transporter genotype is associated with higher anxiety, worse logical reasoning in the context of emotional material, and weaker amygdala-frontal-striatal but stronger amygdala-insula functional connectivity. These findings contribute to the identification of endophenotypes that are necessary for building a causal pathway from genes to disorder.

Neural Loss aversion Differences in Healthy and Depressed Individuals

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Background: The value function of prospect theory suggested by Kahneman and Tversky is one of the successful descriptive models of human decision making behaviours. This model suggests reference dependence of value function and aversion to loosing behaviour called loss aversion and graphically it was observed that the value function was steeper for losses than for gains. The loss aversion coefficient which is a measure of amount loss aversion reported to be around 2 and earlier neuroimaging studies on healthy human participants suggested that the neural loss aversion was sub-served by the cortical and sub-cortical brain regions such as amygdala, ventral striatum and ventromedial prefrontal cortex. However, the neural loss aversion network of brain regions involved in pathologies such as depression is yet to be understood.

Purpose: The aim of this fMRI investigation was to build a robust prospect theory that could explain varied behaviour of loss aversion across psychopathologies such as depression contrasting healthy populations.

Methods: functional MRI scans were acquired while participants (healthy and depression patients) performed a monetary incentive based economic decision-making task customised for Indian population. The data was acquired on 10 participants in each group i.e. either healthy controls or depression patients. We utilized a reduced version of monetary gambles customised for Indian population with decision phase alone i.e., 8x8 loss x gain matrix (as in Tom et al., 2007) with loss values ranging from 50 to 190 with the steps size of 20 and the gain values 100 to 380 with the step size of 40. Participants were told that each of the gamble trial was independent of other trials in the experiment and their task was to accept or reject the gamble and they were endowed with Rs. 100. Accepting a 50/50 gamble would yield subjects to obtain either the loss or gain amount. Rejecting the gamble would yield the current wealth i.e. Rs. 100. The Participants made their choice within 3 seconds after the arrow turns to pink and they were instructed to start deciding about their choice of accept or reject from the onset of the stimulus but could confirm their choice only after the arrow turns to pink. If they exceed 3 seconds, the experimental program will proceed to the next trial with the record of no-decision status. The participants were also instructed that the decision made in each trial should be referred to the amount available as current wealth of that particular experimental run i.e. either acquired from the previous run or endowment for that particular run.

Result: The behavioural loss aversion coefficient for the depression patients (mean=2.18±0.64, median=1.93) was found to higher compared to the healthy controls (mean=1.31±0.64, median=1.82). Whereas, the risk factor for the depression patients (mean: 0.52±1.00, median=1.20) was found to be lower compared to the healthy controls (mean: 1.49±0.13, median=1.56). The functional MRI results suggested common network of brain regions responding to positive gain values and negative loss values (following prospect theory of value function) in right ventral striatum, ventromedial prefrontal cortex and right amygdala in both the groups. However, the neural loss aversion results revealed dissociable sub-cortical region activations such as right dorsal striatum activity for healthy controls compared to depression patients and mid-brain/brain-stem dopemenergic system for depression patients compared to healthy controls. These results suggest interplay between dorsal striatum versus mid-brain regions for this higher-order cognitive behaviour (loss aversion) in healthy controls and depression patients.

Structural and Functional networks underlying auditory processing in children with autism

INTRODUCTION: A wide range of enhancements and deficits in auditory function have been reported in individuals with Autism Spectrum Disorders (ASD). These include impaired perception of speech on one hand and enhanced responses to musical sounds on the other. It has also been suggested that music-based interventions engage a multimodal brain network and may hence be useful in entraining functions which are impaired in autism. The main objective of our study is to identify the structural and functional networks involved in processing spoken speech, sung speech and music in children with autism as compared to typically developing children with a view to designing interventions targeted at entraining these communication networks via early music-based training.

METHODS: We conducted a passive-listening task with three kinds of stimuli –spoken words, sung words and piano tones in a sparse-sampling, event-related fMRI paradigm. Words were bisyllabic nouns or verbs commonly used by children. The task was performed by 44 participants, 22 children with an ASD diagnosed using DSM IV, CARS2 and ADOS criteria in the age range 6-16 years and 22 typically developing (TYP) age and gender-matched controls 90 volumes in 3 runs were acquired with TR=10s in a 3T MRI scanner along with a high resolution T1 image and diffusion images. Data analysis was performed using SPM5 and FSL-FDT.

RESULTS: Our preliminary results showed that sung words engaged a robust bilateral temporal network with in both ASD and TYP. In contrast, the networks recruited for spoken word perception were more right-lateralized in ASD. The spoken networks for ASD also showed decreased inferior frontal activation which was related to the verbal ability in the ASD group. Furthermore, a diffusion tensor imaging analysis revealed that the inferior frontal activation was correlated with the decreased integrity of the white-matter tract connecting left temporal and frontal regions in ASD. A subsequent functional connectivity analysis using psychophysiological interactions further confirmed that fronto-temporal connectivity, which was disrupted during spoken word perception, was preserved during sung-word listening in children with ASD.

CONCLUSION: Our results show that fronto-temporal functional connectivity is preserved during sung word perception across the autism spectrum and is independent of language ability and underlying white matter structure. In summary, our findings demonstrate the ability of song stimuli to overcome the structural deficit for speech perception across the autism spectrum and provide a mechanistic basis for the efficacy of song and music-based interventions in ASD. Future behavioural experiments will lend support for use of such song-based music interventions.

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Effect of COMT, 5-HT2A and 5-HTTLPR polymorphisms on brain morphometry in schizophrenia and healthy subjects

Anupa A Vijayakumari, John P John, Harsha N Halahalli, Bhavani Shankara Bagepally, Pradip Paul, Priyadarshini Thirunavukkarasu, Nagaraj S. Moily, Meera Purushottam, Sanjeev Jain

Abstract

With the advent of neuroimaging techniques like Computerized Tomography (CT), Magnetic Resonance Imaging (MRI) and Diffusion Tensor Imaging (DTI), brain morphometric abnormalities have been extensively reported in schizophrenia. However, apart from enlarged ventricles and whole brain volume reductions, no other brain morphometric abnormality has been consistently associated with the disorder. The main source for this variability could be the genotypic heterogeneity of the study samples, given our understanding that schizophrenia is a polygenic disorder. Moreover, epistatic interactions and epigenetic alterations play a pivotal role in mediating regional brain volumetric changes. We attempted to examine the influence of polymorphisms of three risk genes which mediate monoamine signalling in the brain, viz., catechol-o-methyl transferase (COMT), 5-hydroxytryptamine transporter (5-HTTLPR) and 5-hydroxytryptamine 2A (5HT2A) on brain morphometry in patients with schizophrenia and healthy subjects. The study was carried out at National Institute of Mental Health and Neurosciences (NIMHANS), Bangalore, India. A total of 80 subjects (patients with schizophrenia=41; healthy subjects=39) belonging to Dravidian ethnicity from South India were recruited for this case control study. All the participants underwent magnetic resonance imaging and were genotyped for COMT, 5HTTLPR and 5HT2A polymorphisms. We examined the effect of COMT, 5HT2A and 5-HTTLPR polymorphisms individually as well as additively on regional brain volumes using an imaging-genomics approach. A dominant model of COMT Val158Met polymorphism (Met/Met vs. Val/Met + Val/Val or AA vs. GA+GG) was shown to be associated with brain morphometric changes in healthy young adults (Honea et al., 2009, Zinkstok et al., 2006). In subjects who were at high risk for psychosis, gene-dose effects of the Val allele on reduction gray matter volume in anterior cingulate has been reported (McIntosh et al., 2007). Therefore, we assumed a dominant model for the COMT Val158Met polymorphism to examine the effect of the risk Val allele on brain volumes. Also for the 5HTTLPR polymorphism, a dominant model (Long/Long vs. Long/Short+ Short/Short or LL vs. LS+SS) was assumed, since the short allele was found to act in a dominant fashion (Hranilovic et al., 2004). Voxel-based morphometric (VBM) approach was employed to carry out all the morphometric comparisons using Analysis of Covariance model after adjusting for age, gender and total brain volume. VBM analysis across phenotypes (schizophrenia vs. healthy subjects) showed significant gray matter volume reductions in the left anterior culmen and posterior declive in patients with schizophrenia when compared to healthy subjects at family wise error (FWE) cluster defining threshold (FWEc; cluster defining threshold: $P_{uncorrected} < 0.001$; k= 793 voxels). Irrespective of phenotype, individuals with the risk allele T (n=14) of the His452Tyr (rs6314) polymorphism of 5HT2A showed significantly greater regional brain volumes in the left inferior temporal and inferior occipital gyri (FWEc; cluster defining threshold: $P_{uncorrected} < 0.001$; k= 988 voxels) in comparison to those homozygous for the C allele (n=66). Genotype-wise comparisons of gray matter volumes using the dominant model for COMT and 5-HTTLPR revealed group

differences only at an uncorrected threshold (p<0.001, 20 voxel extent threshold). Subjects with GG or AG genotype of rs4680 of COMT (n=61), irrespective of phenotype, showed decreased gray matter volumes in right anterior cingulate, bilateral medial frontal gyrus, right declive, right superior temporal gyrus, right fusiform gyrus, right uncus, right frontal sub-gyral region and left lingual gyrus compared to those individuals with AA genotypes (n=63). In case of 5-HTTLPR, the individuals carrying SS or LS genotypes (n=63) showed decreased gray matter volumes in the right anterior culmen and middle frontal gyrus when compared to LL individuals (n=17) (p<0.001, 20 voxel extent threshold). Exploration of the additive effects of risk genes on brain volumes yielded differences between those subjects who had 2 or more risk genotypes (n=53) of the above 3 risk genes vs. those who had 1 or less risk genotypes (n=27) at an uncorrected threshold (p<0.001, 20 voxel extent threshold). Those with higher loading of risk alleles had lower regional brain volumes in the right superior frontal and right medial frontal gyri. In conclusion, the volumetric alterations observed in our study can be interpreted as an independent function of the individual and additive effects of the multiple schizophrenia risk genes on brain volume, rather than a function of the disorder per se.

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Three Key Factors in Human Cognitive Evolution

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An adaptation for bodily mimesis implying improved volitional control of the body (Donald 1991) can explain why human beings are particularly skillful compared to non-human primates with respect to imitation, empathy and gestural intentional communication. Since these are arguably prerequisites for language, I have argued that no extra adaptations for the language evolution (except for increased vocal control) need to be assumed (Zlatev 2008a, 2008b).

However, there are at least two questions that remain to be answered: (a) what ecological and social conditions brought about the evolution of bodily mimesis? (b) what lead to the transition from a predominantly mimetic form of communication to a predominantly symbolic one (using the vocal channel)? Hrdy's (2009) proposal that our ancestors underwent a transmission in major reproductive strategy to alloparenting (cooperative breeding) addresses the first question. The answer to the second question will be twofold: First, I emphasize that language is not a purely symbolic ("arbitrary") semiotic code, but a heterosemiotic, multimodal system, where even the vocal component is to various degrees non-arbitrary. Nevertheless, there are unique properties of "symbolic reference" that are absent in iconic-indexical systems. Two recent theoretical proposals of the (gradual) transition of iconic/indexical forms of expression into relatively arbitrary ones will be briefly reviewed (Brown 2012; Collins 2013), and a synthesis suggested.

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Similarities and Differences in Thai and Telugu Motion Event Descriptions

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The binary language typology proposed by Talmy (1991), and extended with an additional equipollent type by Slobin (2004) has been the focus of numerous linguistic and psycholinguistic investigations of motion events (e.g. Bohnemeyer et al. 2007; Filipovič 2007; Croft et al. 2010). Despite occasional reservations, there seems to be a general consensus that e.g. Germanic and Slavonic languages are (1) satellite-framed, i.e. tend to express the Path component of motion events in a satellite, and that e.g. Romance and Semitic languages are (2) verb-framed, i.e. tend to express Path in the verb, while (3) serial-verb languages like Thai (Zlatev &Yanklang 2004) and Ewe (Ameka & Essegbey 2006) differ in providing convenient slots for the expressionof Path, Manner and Deixis.

However, any clear two-type or three-type division of languages on the basis of their expression of motion situations (and extensionsto other semantic domains) is problematic. For other thing, there is considerable intra-typological and even intra-linguistic variation (Croft et al. 2010). Another problem is that the basic concepts of Path, Manner, "Satellite" and even Motion have been ill-defined, motivating the need to re-work motion typology from the ground (Zlatev et al. 2010). As a contribution to this effort, we compare two languages that differ genealogically and typologically to a considerable extent: Telugu (cf. Viswantha Naidu & Vasanta 2011) which is highly inflective and Thai, which is highly analytical. While Talmy (1991) claimed that Tamil (closely related to Telugu typologically) should be seen as verb-framed, and Slobin (2004) offers Thai as a clear example of an "equipollent" language, we first show that these two languages have a number of analogous resources for the expression of motion and spatial semantics:

- Thai uses, as mentioned, series of Manner (wing 'run'), Path (khaw 'enter') and Deictic (ma 'come') verbs, while Telugu combines main verbs expressing Path/Direction or Deixis (veLLADu 'go') with verbal participles of Manner (parigett-kunTu 'run'), as well as "explicator verbs" (cf. Abbi 2004).
- Speakers of both languages express Manner, especially in colloquial circumstances, through (reduplicative) expressives/ideophones, e.g. tàkiaak-tàkaaj 'move frantically' (Thai), cakacakaa 'fast paced walking' (Telugu).
- In addition to verbs Thai uses de-verbalized prepositions (e.g. càak 'from') and Telugu locative case markers (e.g. -nuMDi 'from') to express Path.

- Both languages make systematic use of nominals expressing different values of the category Region, as Thai naj/nOOk and Telugu lO/bayaTi (‘inside/outside’), which in Telugu can take the case markers above, e.g. lO-nuMDi‘from-inside’.

To compare how these resources are used in actual language use, we performed a study in which 15 adult speakers of Telugu narrated the well-known “frog story” based on pictorial stimuli (cf. Strömqvist & Verhoeven 2004), comparing these descriptions with those of 10 adult speakers of Thai, collected previously (Zlatev & Yangklang 2004). Qualitative and quantitative comparisons showed similar rates of expressing the category Path/Direction (through verbs and prepositions/cases markers) and Region (though locative nouns), but higher rates of Manner and Deixis expression in Thai, while Telugu speakers tended to mention Landmark/Ground elements more often. We present tentative explanations of these differences, arguing for the need to take into consideration factors such as “degree of grammaticalization” which have been mostly neglected in motion event typology.

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Aspects of the Hindi Compound Verb

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Compound Verbs (CVs) are constructions consist of a sequence of two verbs in which the second verb is either delexicalised or its semantic domain is considerably altered. While the semantic centre of gravity varyingly shifts towards the first verb (V1), the major responsibility of bearing the grammatical weight is borne by the second verb (V2). For example, in Hindi, the verb bol is 'to speak' and the verb uTh is 'to rise'. The compound verb bol uThA 'speak rise-pst-m' expresses a manner of speaking, namely to speak out suddenly and without according much thought to what is spoken. It is thus different from a pure sequence of two verbs, which represent two contiguous actions. Interestingly, while there are few restrictions on the choice of the first verb, the second verb belongs to a set of closed-class elements.
The literature on compound word processing is broadly divided into the decompositional, non-decompositional and the dual access theories, according to which both types of lexical representations (i.e., constituents and whole-words) may exist simultaneously when processing complex and compound words. At the same time, different factors, such as semantic transparency, cumulative frequency, productivity of the affix, and surface frequency determine which lexical representation is activated (Shabani, 2012).
In the Maximization of Computational and Storage Opportunity model, Libben (2006) maintains that only a polymorphemic word heard frequently enough to be lexicalized is stored as a whole. He further proposes a new extension of the Maximization of Computational and Storage Opportunity model, suggesting that semantic opacity does not discourage constituent activation; instead, it "creates a mismatch of activation". In other words, when processing polymorphemic words, both the full form of the polymorphemic word (if lexicalized due to high frequency) and its constituents are activated. Yet, in case of semantically opaque complex and compound words, there should be a mismatch between the meaning of the constituents and the meaning of the full form. Such a mismatch would inhibit appropriate semantic activation and lead to slower response times in priming experiments and in lexical decision tasks (Libben, 2006).
In the first experiment, we hypothesize that since CVs are mapped on to a single event as against serial verbs which are mapped onto more than one event, the time required to process CVs should be less than that required for serial verbs and more than that required to process simple verbs. Our experimental findings support this hypothesis and indicate that increased complexity in the representation of verbs leads to increased processing times.
For the second experiment, we hypothesize that compound verbs in Hindi are stored and processed as both constituents and whole-words, depending primarily upon the frequency of usage. In the case of CVs, we need to consider the opacity of V2, which result in slower response times in primed lexical decision tasks. Our findings corroborate the above.

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Cognition and Semantic Language Perception in Early Blind and Late Blind Subjects

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Introduction: Functional magnetic resonance imaging, study showed the exploration of the neural substrates of Braille reading. .Braille is one of the few writing systems where tactile and spatial perception is used, which represents recognition, search converting simple tactile information into meaningful patterns that have lexical and semantic properties which may be mediated by the somatosensory system.
Methodology: Ten early and late blind along with ten sighted were recruited (all right handed) from the clinics of our institute. Standard diagnostic and exclusion criteria were followed. Functional MRI scans were conducted on standard clinical 3T whole body MR scanner (Achieva 3.0T TX, Philips, Netherlands) with the subject in supine position. For Semantic processing: patients were presented braille tactile input and the cues were presented by using E-prime software. Single-shot echo planar imaging (EPI) sequence was used to study the Blood oxygen level dependent (BOLD) effects in the whole brain. Pre- and post-processing was carried out using SPM8 (Wellcome Department of Cognitive Neurology, London, UK). One sample t-test ($p<0.001$, cluster threshold 10) was used for group analysis.
Results: During the semantic task in early blind subjects, BOLD activation was observed in bilateral inferior temporal gyrus and inferior parietal lobule, left hemispheric cerebellum, somatosensory association cortex, premotor cortex and supplementary motor cortex and primary somatosensory cortex, right cerebral dorsolateral prefrontal cortex, pars opercularis, part of Broca's area, and superior frontal gyrus. In late blind subjects, activation was observed in bilateral inferior frontal cortex, left secondary visual cortex (V2), primary somatosensory cortex, premotor cortex and supplementary motor cortex, along with right pars triangularis broca's area, and associative visual cortex (V3, V4, and V5), with dominant activation in left hemisphere. Though controls had not learnt Braille, the study was carried out in them to observe the tactile perception. In controls the response to the task was in bilateral inferior frontal gyrus and inferior parietal lobule, right hemispheric dorsolateral prefrontal cortex, insula and claustrum and left hemispheric post-central gyrus and the most rostral superior frontal gyrus. Both hemispheres were active in sighted controls while dominant activation was observed in left hemisphere after analysis in late and early blind participants during the semantic task.
Discussion: The visual cortex of blind subjects is functionally relevant to Braille reading, suggesting plasticity for additional processing of tactile information in the visual cortical areas. Inferior parietal lobule in BA 40 is involved in reading both in regards to meaning and phonology [1]. Consistent with this possibility, sighted and blind participants alike manifested higher responses in premotor and prefrontal cortex during the semantic task [2]. Late blind subjects showed a significant activation in extrastriate area of visual cortex, whereas such an activation was absent in early blind subjects [3]. Activation of the cerebellum hemispheres has seen in Braille reading in early blind that may involve in tactile discrimination and motor control [4]. It has been suggested that activity in secondary visual cortex (V2) and associative visual cortex (V3, V4, V5) during braille tasks represents a shift in modality selectivity of those areas, enabling them to contribute directly to perception rather than visual.

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Semiotics, names and the titular projection

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Cognitive inquiry cannot afford to work with a sharp boundary between ‘problems’ amenable to scientific tackling and ‘mysteries’ lacking this property. Instead, it becomes necessary to explore the porosity of the problems-mysteries interface with respect to specific phenomena. In this paper, which extends earlier work on the semiotic and linguistic properties of names, we examine a ‘problem’ that has been opened up for rigorous investigation only recently, in the context of the study of the Eastern Indo-Aryan language Bangla (a.k.a. Bengali). What we shall call Titular elements – such as /babu/ ‘mister’, /mOSai/ ‘excellency’, /dada/ ‘elder brother’ and /didi/ ‘elder sister’ – were first studied by Ghosh 2006; she calls them Honorific Words. She argues that they are distinct from classifiers. Her argument rests on their compatibility with the plural format /Nra/. In the present paper we consider further facts – that a titularized nominal can occur in the classification format /NTa/, and that examples with title recursion sometimes work, as in /mitrobabumOSai/ ‘his excellency Mr Mitra’, /indudidiSona/ ‘our dear elder sister Indu’ – and propose that the relevant word formation strategy should have formal freedom of action supplemented by semiotic principles that require some rise in the level of either respect or endearment in order to license actual applications of the recursive option. It is in the semiotics that problems meet mysteries, posing new experimental and theoretical questions for cognitive inquiry to address.

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The relationship between auditory rhythm processing and language and literacy skills in the early-adolescent brain

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The relationship between auditory processing and language and literacy skills has been a matter of debate. Whilst most previous work focused on single-sound processing (Goswami et al. 2002, Rosen et al. 2009, Tallal 1980, Witton et al. 1998, Wright et al. 1997), more recent studies have used melodic (Foxton et al. 2002; Ziegler et al., 2012) or rhythmic stimuli, in particular in comparing dyslexic to typically developing children (Overy 2003, Huss et al. 2011, Richardson et al. 2004).

My work investigates auditory processing systematically, at increasing levels of complexity from single sounds to sound sequences, with one specific focus on rhythm processing and in adolescent language development. In a large cohort of typically developing school children (age 11+; n=210), the data demonstrated a specific significant correlation between short simple (isochronous) rhythmic-sequence processing and phonological language and literacy skills alongside one for pitch sequences (Grube et al. 2012). In a subsample of individuals with dyslexic traits (n=28), the correlation with language skill differed for some tasks, but very similar to the typically developing for the processing of short rhythmic sequences (Grube et al., 2014). In a cohort of young adults (undergraduate students) in contrast, there was a strong, significant correlation between language and literacy skills and the processing of longer sequences with a metrical or a quasi-regular beat (Grube et al., 2013) that was not found in the younger cohort. This finding is currently further investigated in two cohorts (mean age 12 and 14).

Overall, the results suggest a beneficial role for beat-based rhythm processing in the early-adolescent development of language and literacy skills. This finding provides behavioural evidence in support of recent models of oscillatory brain activity at corresponding frequencies reflecting the use of the quasi-regular temporal structure of speech, i.e. as a “temporal scaffolding” (Abrams et al. 2009, Giraud & Poeppel, 2012; Ghitza, 2013). Such mechanisms may provide a common basis for both music and speech, and the link between the two (Besson, 2001; Strait et al., 2013).

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Group differences for Rotation Related Negativity (RRN) while Reading

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Mental-rotation is the well-known phenomenon that reaction time increases linearly with the angles of rotation. Dyslexics are not impaired responding on mental rotation task but they fail in suppression of symmetry in the representation of graphemes at decision stage. This deficit is termed as Functional Coordination deficit (Lachmann, 2002) between grapheme and phonological letter representations in dyslexics. The behavioral results so far indicated that group effect in mental rotation tasks occur late, in the decision stage of information processing (Heil, 2002). Neuronal mechanisms underlying mental rotation are still discussed. Therefore psycho physiological methods need to be applied to understand the neuronal group differences by using the paradigm of mental rotation. Letters G, F and R were used with no visual or phonological similarity and were presented in normal and mirrored rotations forming three different levels of angular disparity of rotation from upright position with a difference of 60^0 each. We expect Rotation Related Negativity (RRN) as a function of the complexity associated with angular disparity of rotation resulting to reduced late positive component. Where the perceptual encoding of mental rotation task for dyslexics and control children occur? Both the groups perform mental rotation at the same time? Or it's an early or late processing for dyslexics in comparison to controls? The data was collected on German's 12 dyslexic children, 19 control children. In general, reaction time increased with an angular disparity of rotation (Heil & Rolke, 2002). As predicted, identical effects of mental rotation occurred for both the groups (Rusiak, Lachmann, Jaskowski and van Leeuwen, 2007) and Dyslexics were slower in responding to the letters than control children because of the visual and phonological problems for encoding of letters at the decision stage (lachmann, 2002). According to the ERP's RRN was present for Parietal electrodes (P3, Pz and P4) and was absent for frontal (F3, Fz and F4) and central (C3, Cz and C4) electrodes. Bilateral effects of rotation for parietal electrodes (P3, Pz and P4) were found with no hemispheric advantages for both groups. RRN was present only for controls in the time window of 400-700ms. Dyslexics showed some late effects (800-1000ms) in perceptual encoding but the typical trend of RRN was absent. Possibly, they showed reduced RRN because they were engaged more in distinguishing between normal and mirrored rotations. Differences between the groups in the later time window (800-1000) could also be explained as confusion between normal and mirrored rotations. On the other hand the results also suggest that dyslexics were using a different strategy for performing mental rotation (Horst et al., 2012).

Perceptual Span of Readers of Hindi in Devanagari

This study was conducted to determine the size of the perceptual span of readers of Hindi written in Devanagari through eye-tracking experiments. The symmetric region of maximal visual acuity surrounding a fixation, called the visual span, is very narrow, extending to about a degree on either side of the fixation. The perceptual span, on the other hand, has been defined as "the size of the effective visual field in reading" (Rayner 1998). It is the optimal number of characters that can be seen by a reader, which, when decreased, affects reading but when increased does not facilitate reading. The two have been found to be incongruent in studies on English (McConkie & Rayner 1975), Chinese (Chen & Tang 1998), Japanese (Osaka 1992, 1987) and Hebrew (Pollatsek et.al. 1981) showing thereby that perceptual span is not entirely determined by visual acuity.

Perceptual span is affected both in size and symmetry by the script and possibly by the language that is being read. In English the perceptual span extends to about 14-15 characters to the right of the fixation and 3-4 characters to the left (McConkie & Rayner 1975). The perceptual span in reading a typical Japanese text consisting of a combination of *kana* and *kanji* scripts extends to only 7 character spaces to the right (Osaka 1987, 1992). Chinese has a perceptual span with 3-4 characters to the right of fixation and information to the left of the fixation does not seem to have any significant effect on reading speed or accuracy (Chen & Tang, 1998).

Although previous works have suggested a role of information density in modulating perceptual span (Chen & Tang, 1998), the types of information that do so, need further study. Based on the findings of studies conducted in different languages, we designed and ran a set of experiments to determine the size of the perceptual span for readers of Hindi written in the Devanagari script. Our hypothesis is that the perceptual span for readers of Hindi in Devanagari will fall between those for English and Chinese because of the phonemic density of the script.

Experiments I & II

The two experiments involved eye-tracking, on an Eyelink 1000 (SR Research) eye-tracker. The experiments were run on 20 subjects. There were 50 sentences, each with 5 conditions, which were counterbalanced, displaying one condition of each sentence to each subject using Rayner's gaze-contingent moving window paradigm (Rayner 2001). Every participant therefore ran through 50 trials in the experiment. The first two experiments were controlled for the number of aksharas or blank spaces displayed to the left of the fixation, with no restriction on the number of aksharas or blank spaces displayed to the right of the fixation. The control condition required sentences to be completely displayed with no visual restrictions on either side. A multiple choice question followed each sentence to test reading accuracy.

Experiments III and IV

The second pair of experiments used the same set of stimuli and followed the same design as the first pair of experiments. The number of characters to the right of the fixation were controlled using a gaze-contingent moving window paradigm, with no restrictions on the number of aksharas or blank spaces displayed to the left of the fixation.

Experiment V

This experiment had a similar set of stimuli, with an additional 90 sentences added to the set of stimuli in the previous experiments. Each participant ran through 140 sentences.The design of the experiment was the same as in the first two sets of experiments except that there were only two conditions: a control condition in which the stimuli were displayed in their entirety without any masking on either side of the fixation and a second condition using the gaze-contingent moving window paradigm displaying only the aksara fixated upon along with three aksharas to the left of the fixation and seven aksharas to the right, based upon the results obtained from the previous experiments.

Results

Experiment I, II, III and IV

The reading time for each stimulus was measured under the various conditions. The reading time for the control condition, where the whole sentence was displayed with no restrictions on visibility was taken as the base with which the reading times under all the other conditions were compared. A linear mixed model was used and the log of RT (Reading Time) was taken as the dependent variable. The statistical analysis in the first set of experiments showed that the condition with 3 characters visible on the left of the fixation allowed significantly faster reading than all the other conditions except the control condition. In the second set of experiments, the condition with 7 characters on the right of the fixation allowed significantly faster processing compared to all the other conditions except the control condition ($P<0.05$ in both cases).

Experiment V

Experiment V confirmed the results from the previous experiments. There was no significant difference in reading time under the two conditions.

Conclusion

The five experiments mentioned above led to the conclusion that the perceptual span of readers of Hindi in Devanagari consists of 11 aksharas (including blank spaces): 3 to the left of the fixation, the akshara under fixation and 7 aksharas to the right of the fixation.

What is the Role of the Motor System During Action Understanding?

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When we observe other people's actions, brain regions are recruited that are also involved when we perform actions ourselves. A dominant view in the literature is that the recruitment of premotor and motor regions plays a causal role in the process of action understanding. Alternatively, it has been suggested that the cognitive processes underlying action understanding are represented elsewhere, and that premotor and motor regions are recruited as a consequence of action understanding. In this talk, I will discuss several neuroimaging experiments that aim to provide insight into this debate.

Motor Adaptation Deficits in Ideomotor Apraxia

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The cardinal deficits observed in ideomotor limb apraxia are thought to arise from damage to internal representations for actions, developed through learning and experience. However, whether patients with limb apraxia can learn to develop and refine new internal representations with training has not been investigated in detail. This is important in order to understand whether physical rehabilitation, which is based on motor training, can be effectively employed to improve motor deficits in apraxia. Therefore, we examined the capacity of apraxic patients for motor adaptation, a process associated with the development of a new representation of the relationship between arm movements and their expected sensory effects. We tested 13 healthy adults, 12 left hemisphere damaged apraxic patients and 11 left hemisphere damaged nonapraxic patients in a visuomotor adaptation paradigm. Subjects initially performed point-to-point reaching movements in a virtual reality environment in which visual feedback about hand motion was provided and matched with the actual direction of hand motion. This block of trials established baseline levels of performance. Next, subjects were required to adapt their actions to a novel visual-motor mapping in which the direction of cursor motion was rotated by 30 degrees relative to the direction of hand motion. After this block of trials, subjects re-performed the baseline block, which enabled us to test for the presence of after-effects of adaptation. Our results demonstrate that healthy adults and nonapraxics clearly adapted to the rotation and demonstrated significant after-effects when the rotation was removed. In contrast, apraxic patients showed an initial rapid change in performance, but failed to make any improvements thereafter. When the rotation was removed, apraxics demonstrated an early after-effect of the same magnitude as the two other groups likely reflecting the initial learning, but this after-effect was not sustained and performance returned to baseline levels much more rapidly. Thus, the early phase of learning appears to be intact in apraxia, but leads to the development of a fragile representation that is rapidly forgotten. Apraxic patients had larger lesion involvement in the left inferior parietal cortex, pointing towards a key role for this region in the process of learning to form stable internal representations.

A dedicated common network underlies the initiation of eye and hand effectors during a coordinated movement

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The computational architecture that enables functionally and anatomically independent eye and hand effector systems to generate coordinated movements is not known. The simplest and intuitive architecture is to assume that eye and hand effectors are controlled by completely independent and parallel networks which when driven by a common visual input generates coordinated eye hand movement. To test this, 8 subjects were recorded while they performed goal directed movements under three different conditions of eye-alone, hand-alone and eye-hand. We found that reaction time (RT) of the saccades that were accompanied by a hand movement were delayed; while hand movements were faster compared to their respective independent conditions. The shift in the mean RTs of eye and hand is evidence of interaction between the two effectors systems. Using a drift diffusion accumulator model - a widely used model to fit RT data- we show that independent but interacting accumulators that controls the initiation of eye and hand movement cannot account for the observed data completely.

In contrast to the interacting accumulator model, the common command hypothesis (Bizzi et al 1970) is another architecture that explains eye-hand coordination. Thus far, the only evidence to support this idea was the presence of high temporal correlation between eye and hand RTs, which has been reproduced in some studies. We have, for the first time shown using psychophysical experiments and computational modeling that common command hypothesis is a valid architecture to generate coordinated movements. Our data shows that even though the mean hand RT is greater than the mean eye RT by ~100 ms, the variances of the two distributions are comparable; i.e. the variances do not scale with the mean. We also show that the observed pattern of variances of the eye and hand RTs is compatible with a single accumulator instantiating eye and hand movements and that the difference in means of the eye and hand RT can be accounted for by a temporal delay. We also have found a physiological signature of the predicted delay in the electromyography (EMG) activity recorded from the shoulder muscles of subject as the time interval between the onset of the EMG to the onset of the hand movement. Finally, we found that the common command model could only account for the coordinated movements but not eye and hand movements executed in isolation. Taken together, these observations suggest that coordinated eye hand movements may be generated by a dedicated circuit that operates on the principle of the common command architecture.

Cognitive Science: A Military Psychology Perspective

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Military psychology is a subject matter which is based on traditional methods in psychology with a focus on deliverability. Of late the focus in military psychology has been changing with the change in military context like low intensity conflict, non-conventional warfare, and non-platform-centric engagements. These contexts are bringing change in the military technology, the speed of which has hastened to the extent that human skill development is falling short of the technology development. To bridge the gap between technology development and human capability, the need for introducing cognitive science in the military domain has been felt very strongly in recent times. Human cognitive threshold is thus being enhanced with the help of technology or being replaced with alternative / assistive technology. Efforts are also being made to reproduce the cognitive ability in man-made pre-programmed robot. To conduct such research, military psychology has started engaging the practices of neuroscience, computer science and behavior science under the banner of cognitive science. The present talk will focus on cognitive science with such interdisciplinary perspective in the domain of military psychology.

The Influence of Spatial Cueing on Serial Order Visual Memory

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One of the important functions of vision is to provide a representation of the world that can be kept in our short term memory to guide action. Visual processing of objects in space involves both selective spatial attention (Roggeman et al., 2010; Melcher & Piazza, 2011) and visual working memory (Awh, Vogel, & Oh, 2006). It is well known that visual short term memory and spatial attention share similar mechanisms and neural substrates (Corbetta, Kicade, & Shulman, 2002; Awh et al., 2006; Corbetta et al., 1998). Studies on primates and adult humans have indeed identified common neural substrates that are activated for visual spatial attention and visual short term memory (Awh & Jonides, 2001; Bisley & Goldberg, 2006). Most common tasks used to probe visual spatial attention involve spatial cueing for target detection (Posner, 1980), visual search (Muller & Rabbitt, 1989), and change detection (Fernandez-Duque & Thornton, 2000). These paradigms generally elucidate that spatial cueing when valid (i.e., the cue gives truthful information regarding the location of the target), facilitates effective encoding and detection of the target stimulus. This facilitation is measurable through reaction time and accuracy. Invalid cues, however, are disadvantageous to target detection in terms of RT and accuracies. On the other hand, most common visual short term memory tasks involve recall of items presented serially in the same spatial location (Amiez & Petrides, 2007), or change detection for items presented simultaneously on different locations on the screen(Xu & Chun, 2005; Vogel & Machizawa, 2004; Todd & Marois, 2004) . Serial presentation paradigms generally tend to follow the standard serial recall curves for primacy (Murdock & Bennet, 1962) and recency effect (Waugh & Norman, 1965). In simultaneous presentation paradigms with simple color or shape stimuli, participants can usually detect changes accurately where there are four or less items (Xu & Chun, 2005; Vogel & Machizawa, 2004). However, there have been few studies that probed the effect of spatial cueing on serial recall. We wanted to explore whether spatial cueing can affect serial recall. Spatial cueing guides selective attention to certain locations, facilitating effective encoding of the items in those said locations. Thus, spatial cueing should improve serial recall of items presented in different locations, measurable in reduced RTs and improved accuracies if all or some of the items were probed with valid cues. In contrast in the case where spatial cueing does not carry any relevant information towards the location of the items presented (invalid cues), recall facilitation may not be observed. We also wanted to probe deeper into the stimulus feature itself by looking at colored squares or grayscale shapes. We know from previous studies, that color and shapes are processed differently (Corbetta, Miezin, Dobmeyer, Shulman, & Peterson, 1991). As the short term memory is a limited capacity system (Miller, 1956; Todd & Marois, 2004), we also varied the set size of items to presented between (2, 4, 6, 8). Our studies show a very clear dissociation between color and shape recall. While spatial salience cues seem to facilitate shape recall, they seem to degrade the color recall performance. This effect becomes significant for shape-location trials beyond the working memory capacity limit of 4 items. The results can be interpreted as if individuation of colored objects draws from the same attentional resources as spatial attention and the resulting competition degrades performance in serial order judgment involving color whereas shape recall does not seem to be subject such competition.

Conscious Recognition of Neuro-Feedback

Introduction: The aim of this paper is to assess Neuro-Feedback as a method for studying the relationship between neural activity and subjective experience. We will operate within the specific context of frontal lobe alpha-beta rhythms, and mental states like 'relaxing' and 'concentrating'.

Traditional Neuroscience treats subjective experience as an epiphenomenon and therefore, doesn't engage with it directly. As a reaction to this trend, the program of Neuro-Phenomenology was put forth (Varela, 96). Here, both experience and neural activity are placed on equal footing. The aim is to study the ways in which they mutually constrain each other rather than assuming one is causally prior to the other. This alternate line of inquiry has much to contribute to mainstream Cognitive Science, but it faces a number of hurdles. Notably, there's the practical difficulty of collecting first person and third person data along a common timeline, and then the theoretical problem of establishing causality between data from two completely different epistemological domains. A recent paper (Bagdasaryan, 2013) discusses these challenges at length and offers Neuro-Feedback as a pragmatic solution.

Neuro-Feedback setups involve subjects learning to regulate their own neural activity. This is made possible by transforming their neural activity into visual or auditory sensory stimuli. In this way, the stimulus both affects, and is affected by, the subject's brainwaves. This has a fairly long history of being used for Psycho-Therapy, but the same can't be said of its use as a research tool in the Cognitive Sciences. This is surprising, because as a paradigm it can offer a number of advantages. This is because in Neuro-Feedback, subjective experience of perceiving and controlling a certain neural activity becomes braided with objective measures of the same, in an iterative causal loop (Bagdasaryan et al, 2013). This potentially allows us to overcome both the practical challenge of placing data from first and third-person approaches along a common timeline, and the theoretical challenge of establishing causality between the two.

Method: For us to realize this potential, however, we need to first establish that there is, in fact, a subjective experience of perceiving and controlling neural activity that is accessible to our conscious selves. For this, we offer a simple experiment, where subjects discriminated between auditory feedback, and non-feedback situations. Here, subjects were made to put on an EEG cap developed in our lab (built using only open-source resources), and also a pair of earphones (this was done after obtaining informed consent according to appropriate ethical standards).

In the feedback cases, the tones coming out of the earphones depended on the subject's neural activity according to some rule (frontal lobe alpha/beta ratio mapped to pitch of MIDI piano tones), while in the non-feedback cases, the tones did not depend on the subject's neural activity at all, and instead were coming from a pre-recorded file. The only way subjects could discriminate between the two cases was to learn to consciously perceive how their mental states related to the tones in feedback or to consciously control the tones by manipulating their own mental state. All other possibilities, like subjects using muscular activity instead of mental activity, or recognizing some artifact present in the recorded sound, were controlled for.

Results: We found that subjects could discriminate between the two cases with a frequency higher than chance. We also collected the cognitive strategies subjects used through an interactive interview which involved the subject demonstrating, in real-time, his or her strategies to the interviewer. In general, we found that subjects who adopted a control strategy over an estimation strategy did better, which agrees with studies in the literature which claim that our perceptual abilities come after our control abilities during the development of new sensorimotor skills (Kotchoubey, 2002). Largely, subjects used what can be called a 'relaxation' strategy for driving the tones one way (higher pitch), and a 'concentration' strategy for driving the tones lower (in pitch). This agrees well with the literature on alpha and beta rhythms, but more than that it also adds interesting nuances to what we mean by the words 'relaxation' and 'concentration' if indeed those are the most apt terms to describe the mental actions that best relate to the alpha -beta ratio.

Future Studies: In the future, we plan to see how users get better with more training, and how these skills transfer to situations where there's no help from any artificial device. We also want to explore other setups with the device involving more features of the brainwaves, and in turn 'richer' soundscapes. Within these setups it would very interesting to see what meaning the various qualities of the tones will carry about mental states/actions; what will it mean for the tones to be 'mellow' or 'steady' or 'stretched' or 'flat', and how will the meaning vary among the different subjects.

Keywords: Neurofeedback, Alpha Rhythm, Brain Music, Neurophenomenology, Brain States, Perception

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Dynamical Control of Hierarchical Stimuli

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Recently, there has been a lot of emphasis on treating control as a notion to understand the processes involved in a number of cognitive phenomena such as, intentional binding, and experience of agency. Increase in control results in increased sense of agency. In terms of hierarchical event-control, the level at which control is achieved influences intentional binding and sense of agency. Given the importance of control, we investigated how the amount of control that one can exercise in given situation influences how participants act in a dynamic fashion. We asked participants to control the perception of a particular stimulus on screen by using a single key press (change to target stimuli whenever the target changes to a non-target stimulus on screen). The target and non-target stimuli varied either at the global level or at the local level in an hierarchical stimulus. We also varied the noise in the environment in terms of time after which the non-target stimulus appears on screen (mean delay = 1000ms, SD=±100ms or SD=±300ms). Both the manipulations were blocked, with each block containing 300 continuous trials. At the end of each block, participant was asked to give a confidence rating for sense of authorship in the preceding block. We performed two sets of analysis firstly, involved studying the mean reaction time and rating for sense of authorship. Secondly, we performed a ‘Detrended fluctuation analysis’ (DFA) for the each of the continuous trial series across all participants. Results suggest that for static measures (mean RT, mean IRI, & authorship rating) participants show a higher value (faster for RT and IRI) in the low noise condition, but do not show a change with scope. However, the time-series analysis suggests that scope also plays a role in influencing the underlying control process. DFA, for RT suggests that there is a greater long-term effect (higher value) in low noise condition compared to high noise condition, for global level. For local level, there is no difference between low and high noise conditions. For IRI data, both scope and noise show a main effect, with more influence of long-term processes for global compared to local blocks, and more influence of long-term processes for low noise compared to the high noise condition. Results indicate the nature of cognitive processes dynamically operating in time depend on the level at which information changes.

Distinguishing conceptual from motor decisions

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Many neurophysiological studies have reported that the same areas show activity during motor planning and decision making. Does this mean that decisions are made within the same sensorimotor circuits that are responsible for planning and executing the associated actions? Such an intentional framework rejects the notion of conceptual decisions that are qualitatively distinct and separated from sensory and motor information, but it can be argued that the intentional framework has been biased by experiments that require overt reports, thereby confounding conceptual and motor decisions. I will present recent human imaging work in which we have attempted to disentangle perceptual decisions from motor decisions (Schwarzbach & Caramazza, in preparation) by successively presenting two stimuli (S1 and S2) and having participants perform a two-step task in which a non-motor perceptual decision on S1 determined what participants had to overtly report about S2.

We found that the BOLD signal increased bilaterally in frontal and parietal areas also in the absence of motor demands. On the other hand motor areas showed an increase in BOLD only when participants made overt responses.

Our results show that activity in motor areas reflects the motor decision (preparation and execution) but not the perceptual decision, while other areas reflect perceptual decisions abstracted from the input domain and the behavioral output. We argue for the notion that the brain represents conceptual decisions distinct from sensory and motor information.

The single neuron and prediction errors

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Adaptive biological behaviour is underwritten by a network of stochastic components, in which information processing has to contend with dynamical itinerancy and random fluctuations [1]. The computational repertoire of such a dynamical system is shaped by structural and functional constraints where a multitude of costs and benefits interact to determine adaptive fitness [2]. Over a number of years, the variational free-energy principle [3] has been successful in explaining various aspects of this adaptive computational repertoire i.e., perception, action and learning in the nervous system through a simple idea – the minimization of prediction errors. In this review talk I will first contextualise the implicit message passing in cortical hierarchies that underlies perceptual inferences (using simulations of perceptual categorisation and omission related responses). I will then address the utility of the variational free-energy framework in understanding computations at the synaptic level. Specifically, we consider (a) What constitutes an effective dialogue between the pre-synaptic input and the post-synaptic state? (b) How can the principle of least action equip the synapse with task-specific synaptic learning rules? and (c) How does spike-time dependent plasticity (STDP) enable a reduction of the pre-post state prediction error?

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A computational model of dopamine-serotonin modulation in Basal Ganglia: Towards understanding the cognitive deficits in Parkinson's Disease patients.

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Extended Abstract

Summary:

Efficient decision making typically requires optimizing a dual objective: maximize reward; while minimizing risk. In our risk-based decision making framework, this dual objective is embodied in a Utility function (U) which is a linear sum of expected reward or Value, V, and reward variance or Risk, h. Experimental evidence suggests that the striatum serves as a substrate for value computation (O'Doherty et al, 2006). In our recent modelling work, we proposed that the striatum can compute risk also in addition to value, opening up the possibility that the Basal Ganglia (BG) are capable of risk-based decision making. In that model it was proposed that the serotonin (5HT) in the striatum can be interpreted as the weighting factor that combines value and risk terms in the utility function (Priyadharsini et al., 2012). This novel way of associating 5HT to risk based decision making successfully reconciled the diverse functions of this neuromodulator in reward, punishment, and risk learning, under a unified framework.

The model of Priyadharsini et al. (2012), which was a lumped model, is currently expanded into a network model of BG. We show, from theoretical considerations, that the activity of D1R expressing Medial Spiny Neurons (MSNs) in the striatum represents value, while the activity of MSNs that co-express D1R and D2R can represent risk. We propose that serotonergic projections to striatum modulate the activity of D1-D2 co-expressing neurons, so as to alter risk-sensitivity. The proposed network model of BG was applied to explain the results from the following cognitive test beds: 1) a stochastic two armed bandit problem of bee foraging (Real et al, 1981), and 2) *a reward learning study on healthy controls and Parkinson's Disease (PD) patients by Bodi et al. (2009) showing an increased reward sensitivity in the recently medicated patients, whereas an increased punishment sensitivity in the never-medicated PD patients*.

Introduction:

Decision making in Reinforcement Learning (RL) involves maximization of the rewards obtained. When these rewards are uncertain, the optimal policy should seek to minimize the variances in the reward (also termed as *risk*), while maximizing the mean of the rewards received on executing an action [1]. In risk-based decision making, this composite aim is achieved by combining the mean reward (Value) and reward variance (Risk) in a single function known as the Utility function [2]. A group of nuclei in the midbrain called the Basal Ganglia (BG) are functionally capable of performing this task of risk based decision making [3] through RL [4]. BG dynamics

affect the action selection through direct pathway (DP) or indirect pathway (IP) [5] – the terms DP and IP notify the method by which BG influences the cortical activity that eventually controls action execution. The direct influence of the striatum (nucleus that is the major input port of BG) on Globus Pallidus interna (GPi: nucleus that is the output port of BG) is known as DP; whereas the indirect influence of the striatum through Globus Pallidus externa - Subthalamic nucleus (GPe-STN) on GPi is known as IP. Neuromodulators such as dopamine (DA) and serotonin play key roles in BG's action selection dynamics.

Serotonin is known to influence risk based decision making – On reducing the level of brain tryptophan (a serotonin precursor) risky choices are more preferred to safe choices [6, 7]. In our earlier work [8], we have proposed that the role of serotonin in BG can be interpreted as the weighting factor that combines value and risk in utility function. The model of [8] was able to explain the some of the divergent roles of serotonin in punishment sensitivity, time scale of reward prediction, and risk sensitivity, and combine them in a single framework. In that model, dopamine (DA) was interpreted as Temporal Difference error (δ) consistent with its interpretation in actor-critic models of BG [4]. The model of [8] was a lumped model that did not concern with mapping the various components of the model to biological counterparts. In this work we present a network model of BG, cast within an expanded Reinforcement Learning (RL) framework. *This network model of BG is tested on various tasks, to prove its efficiency in modelling dopamine and serotonin regulated risk based decision making.*

Methods:

In the proposed model (schema in Fig. 1), the value (V) function (Eqn. 1a) is related to the activity of the D1 receptor (R) expressing medium spiny neurons (MSN) in the striatum; and the risk (h) function (Eqn. 1b) to the activity of the D1R and D2R coexpressing (D1R-D2R) MSNs. The utility (U) function [8] is then built as a combination of value and serotonin modulated risk function (Eqn. 1c) in which the serotonin is represented by the parameter α. In the equations, $x(s_t,a_t)$ denotes the cortical input representing a selection function for state (represented by s) and action (a) at time (t); and $W_{D1/D2/D1D2}$ represents the synaptic weight associated with the D1R, D2R and D1D2R expressing MSNs respectively. The response of each MSN (D1/D2/D1D2)R is characterised by its gain function ($\lambda_{D1/D2/D1D2}$) (Fig. 2), which we assume is modulated by striatal dopamine, δ_V (Eqn. 2). We represent the gain function of D1R neurons as an increasing sigmoid of δ_V (Eqn. 3a), whereas for the D2R neurons it is a decreasing sigmoid function of δ_V (Eqn. 3b). D1R-D2R co-expressing neurons are proposed to have an even gain function (Fig. 2), which combines the gain functions of D1R and D2R expressing neurons (Eqn. 3c).

The D1R MSNs in the model project via DP (whose activity is denoted by x_{DP} – Eqn. 4), and the sum of D2R and the serotonin-modulated D1R-D2R MSNs activity project (x_{IP} – Eqn. 5) through IP. The GPe-STN dynamics for input x_{IP} is provided by Eqn. 7. The action selection happens in the GPi (Eqn. 8a) by following GEN (Go-Explore-NoGo) policy that is dependent on the change in utility function (δ_U: Eqn. 6) as opposed to our previous works of using δ_V [5, 9, 10]. Representing the final activity of each pathway as a product of respective $\lambda_{D1/D2}$ (δ_U) and the weights of each pathway ($\lambda_{D1}*W_{D1}*x(s,a)$ for DP, and $\lambda_{D2}*V_{STN}$ for IP) at the GP_i ensures that the higher value of δ_U drives the hill-climbing on the utility function by choosing the same action selected at the previous time-step of the input (x) presentation ('Go' dynamics). The lesser value of δ_U does the opposite by withholding from choosing any actions

('NoGo' dynamics). The intermediary values of δ_U result in exploration of action space ('Explore' dynamics). It is assumed that the connections between GPi (Eqn. 8a) and thalamus (Eqn. 8b) are Inhibitory. The activity in thalamus is taken to be simply the negative of that seen in GPi (Eqn. 8). The action possessing the maximum x_{Thal} is taken to be selected (Eqn. 8b). Here $w_{STN\text{-}GPi}$ denotes the weight of the synaptic connection between STN and GPi, and τ is a time constant.

$$V(s_t,a_t) = W_{D1}x(s_t,a_t) \quad (a)$$
$$h(s_t,a_t) = W_{D1D2}x(s_t,a_t) \quad (b)$$
$$U(s_t,a_t) = V(s_t,a_t) - \alpha\sqrt{h(s_t,a_t)} \quad (c) \qquad (1)$$

$$\delta_V(t) = r - V(s_t,a_t) \qquad (2)$$

$$\Delta W_{D1}(s_t,a_t) = \eta_{D1}\lambda_{D1}(\delta_V(t))x(s_t,a_t) \quad (a)$$
$$\Delta W_{D2}(s_t,a_t) = \eta_{D2}\lambda_{D2}(\delta_V(t))x(s_t,a_t) \quad (b)$$
$$\Delta W_{D1D2}(s_t,a_t) = \eta_{D1D2}\lambda_{D1D2}(\delta_V(t))x(s_t,a_t) \quad (c) \qquad (3)$$

$$x_{DP} = \lambda_{D1}(\delta_U(t))W_{D1}x(s_t,a_t) \qquad (4)$$

$$x_{IP} = \lambda_{D2}(\delta_U(t))W_{D2}x(s_t,a_t) + \alpha\, sign(W_{D1}x(s_t,a_t))\,\lambda_{D1D2}(\delta_U(t))\sqrt{W_{D1D2}x(s_t,a_t)} \qquad (5)$$

$$\delta_U(t) = U(s_t,a_t) - U(s_{t-1},a_{t-1}) \qquad (6)$$

$$\tau_s \dot{u}_{STN} = -u_{STN} + w_{STN}V_{STN} - x_{GPE}$$
$$V_{STN} = tanh(\lambda_{STN}u_{STN})$$
$$\tau_g \dot{x}_{GPE} = -x_{GPE} + w_{GPE}x_{GPE} + V_{STN} - x_{IP} \qquad (7)$$

$$\tau_{gpi}\dot{x}_{GP_i} = -x_{GP_i} + (-x_{DP} + w_{STN-Gpi}V_{STN}) \quad (a)$$
$$\tau_{Thal}\dot{x}_{Thal} = -x_{Thal} + (x_{DP} - w_{STN-Gpi}V_{STN}) \quad (b) \qquad (8)$$

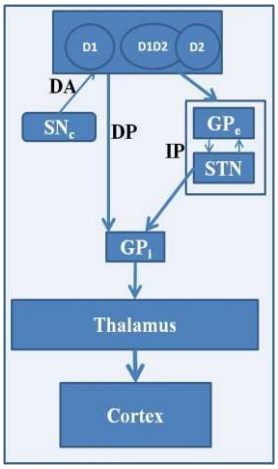

Figure 1: Illustrating the striatal D1R, D2R, D1R-D2R MSNs, Direct (DP), Indirect (IP) pathways of BG.

Results:

This approach has been able to successfully model key properties of risk based decision making, in a stochastic two armed bandit framework. One such behavior that is captured by our network model is the non-linearity in action selection seen in humans – *risk aversive in the case of rewarding outcomes and risk seeking in the case of punitive outcomes* [11] (Fig. 3). The network model also explains the risk sensitive

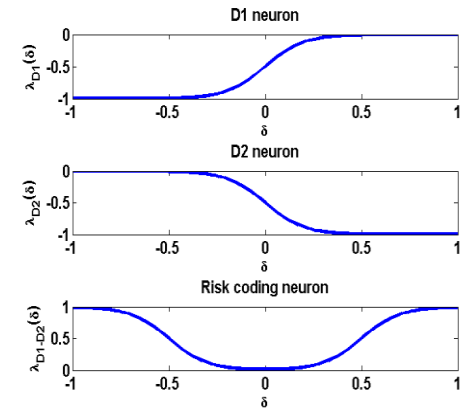

Figure 2: The characteristic gain functions representing various DA receptors containing MSNs. The unit δ on the X-axis defines DA activity. In our study, we assume it to be represented by δ_V (Eqn. 2) or δ_U (Eqn. 6) appropriately.

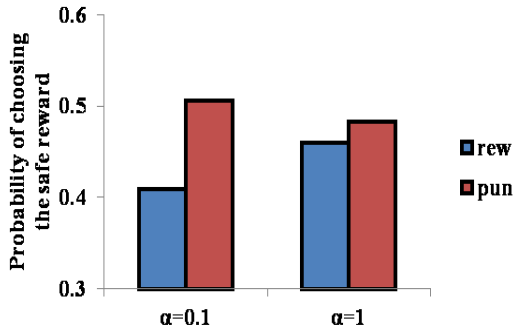

Figure 3: The probability of choosing the safe reward is plotted against α (representing serotonin) in rewarding and punitive cases. In the rewarding case, safe reward: [r = 1; p = 1], risky reward: [r = 2 with a p = 0.5, else r = 0]. Similarly in the punitive case, safe reward: [r = -1; p = 1], risky reward: [r = -2 with a p = 0.5, else r = 0] (here 'r' denotes reward and 'p' denotes probability).

nature of the bees in a foraging task [12] (Fig. 4). Further, we modelled a reward learning study on healthy controls and PD patients by Bodi et al. (2009). In this model, the never-medicated condition was implemented by limiting δ_V in Eqn. 2; and the recently-medicated condition by a constant (>1) multiplicative factor to δ_V. The model reproduces the main experimental results (Fig. 5) viz., *increased reward sensitivity in the recently medicated, while there is an increased punishment sensitivity in the never medicated PD patients* [13].

Finally, we propose that our network model can help us understand the effect of dopamine and serotonin on the BG dynamics, in controls and PD condition, since it takes into account the neurological correlates for the lumped model [8] through the striatal (D1R, D2R, D1D2R MSN) cellular correlate properties present naturally. *This model could be applied to understand the BG-dopamine and serotonin related cognitive and emotional disorders including impulsivity, anxiety, depression, schizophrenia and bipolar disorder.*

Keywords: Decision making, Reinforcement learning, Basal Ganglia, Striatum, Dopamine, Serotonin, Value, Risk, reward, punishment.

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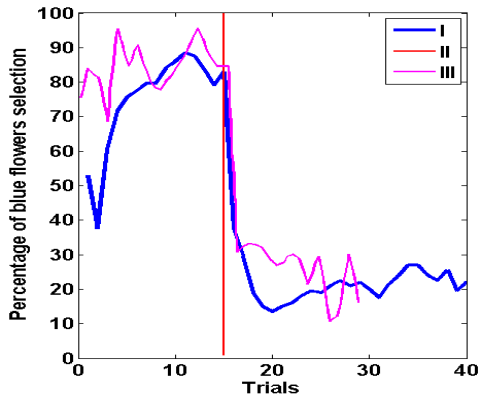

Figure 4: Testing our model on the risk based decision making framework: Implementing the bee foraging task (Real. 1981). The bees were let to forage with blue and yellow flowers providing the same mean reward, but with varying probability. The reward schedule is blue: r = 1(1), yellow: r = 3(1/3) and 0(2/3). The numbers in brackets denote the probability. After a certain number of trials (trial 15: Red line, II), the contingencies were reversed for the blue and yellow flowers. Graph III denotes the expt. result from [12], and I denotes our model result.

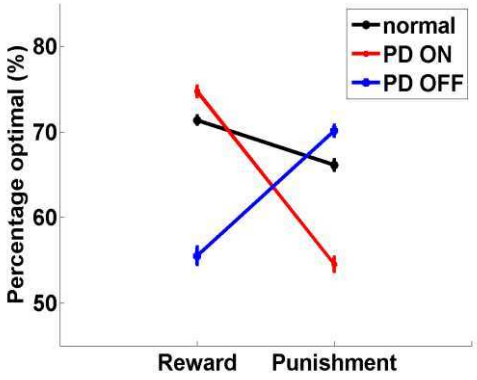

Figure 5: Reward learning in Controls and PD patients (Bodi et al, 2009)

Role of STN-GPe in Decision Making: A 2D Spiking Neural Network Model

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Imagine yourself in a new restaurant looking at the menu card wondering which dish to order. The card lists many different dishes: some of them you know are good, and others you have no idea about. In other words you have two fundamentally different options where one is to order your favorite dish, play it safe and the other is to try something new. How do our minds go about making a decision in this scenario?

The above mentioned example illustrates the classical exploration-exploitation scenario in reinforcement learning (RL), a type of learning shaped by rewards/punishments. Choosing an action that is known to be rewarding is called as exploitation while trying out something new is called exploration. It is by exploring and exploiting that we learn to choose our actions, such that the overall reward is maximized. The curiosity among neuroscientists to discover the neural substrates of exploration and exploitation revealed that areas in fronto-polar cortex and intra-parietal cortex are active during exploratory, while the ventromedial prefrontal cortex is active during exploitative actions. Furthermore, at sub-cortical level the ventral part of the striatum, a key nucleus in the Basal Ganglia (BG) circuit was also active during exploitative actions. A de-cerebrate animal is capable of exhibiting exploratory behavior, hence we expected the presence of a subcortical exploratory area as a counterpart to its cortical version. We proposed earlier that the subcortical neural correlate of exploration is the part of BG consisting of Sub-Thalamic Nucleus (STN) and Global Pallidus externa (GPe). The STN-GPe system being an excitatory-inhibitory network can generate complex and neural activity patterns, a dynamical feature that is suited for exploration.

Using a series of computational models, we had earlier shown that the STN-GPe system can drive exploratory behavior and instantiated this notion by modeling the role of BG in a variety of functions including spatial navigation, reaching, gait and precision grip. But the neural models used in our previous computational BG models consisted of lumped models or abstract rate-coded neuron models. The current BG network is modeled using Izhikevich 2D neuron model, which displays properties of biological neurons. The network model consists of the striatum, GPe, STN, Globus Pallidus interna (GPi) each consisting of 50x50 neurons arranged in 2D lattice. We also modeled a part of thalamus (as an integrator) where action selection is thought to take place.

Parameters in the model were chosen such that the simulated neuron properties were close to biological ones. Synaptic connections, both excitatory and inhibitory were modeled as an exponential decay with decay constants (GABA, NMDA and AMPA receptors) taken from experimental studies. Excitatory (glutamatergic, AMPA and NMDA) synapses were modeled between STN-GPe & STN-GPi and inhibitory (GABAergic) synapses between striatum-GPe and striatum-GPi. The cortico-striatal connections in the model were trained using RL, modulated by the nigrostriatal dopamine signal.

The aforementioned spiking neuron network of BG is applied to an n-armed bandit problem considered in the functional imaging study of Daw et al 2006, used to investigate the neural substrates of exploration. In this task, the subjects were presented with 4 arms and asked to select an arm that gives maximum reward in each trial. The reward associated with each arm was drawn from a Gaussian distribution with a definite mean and variance. To select an arm in a trial, subjects must have an internal representation of each arm and their associated rewards. So,the authors of Daw et al 2006 used soft-max model to predict if the subject is exploring or exploiting. A parameter ‘β’ in the model was used to account for the exploration levels among the subjects.

We compared the performance of the proposed BG model with preexisting behavioral model(soft-max model). The comparison revealed that the exploration parameter ‘β’ from the behavioral model is analogous to the synaptic strength from STN to GPi ($wSTN \rightarrow GPi$). This weight indicates the dominance of exploration, arising from STN-GPe network, over exploitation that is mainly supported by the striatal projections to GPi. Higher the weight ($wSTN \rightarrow GPi$) more would be exploration. The results (% exploitation) obtained from Izhikevich BG model were comparable to soft-max model, which is known to explain the experimental results.

Modeling Choices at the Individual Level in Decisions from Information Search

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ABSTRACT

Information search before making a consequential choice is a practice we commonly follow in our daily life. For example, we try clothes before dressing for a party, and we taste different wines in a wine-tasting before deciding on what to buy. The act of searching for information before making a consequential choice has been studied in the laboratory using the sampling paradigm (Gonzalez & Dutt, 2011; Hertwig et al., 2004).

In the sampling paradigm, respondents are presented with gambles with two options, risky and safe (represented by two blank buttons). The risky option has two outcomes, high and low, with a probability distribution that is unknown to the respondents. The safe option, in constrast, gives a constant outcome with a probability = 1.0 (the respondents do not know this probability). During information search, the respondents can sample both options by pressing on either of the two buttons as many times as they want to and in any order they desire. Each click of a button reveals an outcome that is generated using the underlying probability distribution. Once respondents are satisfied with their sampling, they are asked to make one final consequential choice. Popular models of human choice in the sampling paradigm have so far been used to predict the final choice aggregated across participants (Sharma & Dutt, in press). For example, according to Sharma and Dutt (in press), the Primed-Sampler (PS) model(Hertwig,2011), the Natural-Mean Heuristic (NMH) model(Hertwig & Plesac,2010), and the Instance-Based Learning (IBL) model(Gonzalez & Dutt,2011) are popular algorithms for explaining aggregate choices. However, this aggregation does not explain how individual participants search for information and consequently choose one of the options. Here, we test the ability of the three computational models of aggregate choice to explain individual choices after information search.

The PS model depends upon the recency of sampled information, where the model looks back a few samples on each option before making a final choice. On the other hand, the NMH model is a generic case of the PS model. In this model, one calculates the natural mean of outcomes observed on each option during sampling, making a final choice for the option with a larger natural mean. Similarly, the IBL model consists of experiences (called instances) stored in memory. Each instance's activation is a function of the frequency and recency of the corresponding outcomes observed during sampling in different options. These activations are used to calculate the blended values for each option, where the option with the highest blended value is the one chosen at final choice.

In order to compare human and model choices at the individual level, we consider "observations" in the data. An observation is a participant playing a gamble in a dataset. We evaluate an "error ratio" (i.e., the ratio of incorrectly classified final choices between model and human observations divided by the total number of observations). Firstly, for each observation in human data, we determine the final choice (risky or safe). A similar final choice is then derived for a model observation by exposing the model to the way humans sampled information. This derived choice is then compared to the choice made by the corresponding human observation. The final choices from each of the three models is simulated for 2,370 observations and then compared to the same number of human observations in the largest publically available dataset in the sampling paradigm (the Technion Prediction Tournament dataset). For a model, the error-ratio is calculated as:
Error Ratio = (RS+SR)/ (RS+SR+RR+SS)

Where, RS was the number of observations where the model predicted a safe choice but the human made a risky choice. SR was the number of observations where the model predicted a risky choice but human made a safe choice. Similarly, the RR and SS were the number of observations, where a model predicted the same choice (risky or safe) as made by a human observation in human data. The smaller the value of the error ratio, the more accurate is a model in accounting for individual choices of human participants. For some observations, a model was equally likely to choose a safe or a risky choice. Such cases were discarded from the error ratio calculation and were termed as uncategorized (UN) cases. Thus, more are the number of uncategorized cases; the poorer is the corresponding model's algorithm in accounting for the size of human data.

Our results from model simulation show that the NMH model performs best at accounting for the individual choice and it is followed by the PS and IBL models (see error ratio in Table 1). However, both the PS and NMH models also have 26 and 33 UN cases compared to 0 such cases from the IBL model. These UN cases decrease the efficiency of the NMH and PS models.

Table 1. Summary of results from the three DFE models.

Model	**Parameters**	**UN Observations**	**Error ratio**
PS	N = 17	26	0.173
NMH	-	33	0.161
IBL	d=9.42, σ=0.32	00	0.255

Up to recently, literature in judgment and decision making had compared models by evaluating their performance at the aggregate level. In such comparisons, the average risk-taking from the model was compared to the average risk-taking from human data. However, we compared a model's performance at the individual participant level. We find that that the top three models of aggregate choice are able to account for individual choices up to a certain extent (error ~ 15% to 25%). Our immediate future research in this area will be to investigate the reasons for the errors from models in more detail and to improve model algorithms to achive greater accuracy.

Keywords: Instance-Based Learning, Natural-Mean Heuristic, sampling, choice, decision making, cognitive models.

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Social Influence on Evolution of Cooperation

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Evolution of cooperation based on social information is interesting because many social decisions such as to cooperate or defect in public good games are influenced by a number of decisions already made by other individuals and how the information about these decisions is transmitted via social interactions. However social information is noisy; this might be because of the transmission fidelity of information or limited cognitive capacities of individuals. In case of uncertainty, individuals use probabilistic information to decide about cooperation rather than cooperate or defect with certainty. To understand the evolution of cooperative strategies, we consider a population consisting of unconditional cooperators, unconditional defectors, and social actors. Unconditional cooperators always cooperate and unconditional defectors always defect according to their behavioral types and their decisions do not dependent on population composition. Social actors are the individuals who either cooperate or defect according to social information they acquired through social interactions. The social actors' decisions are dependent on the composition of population and reliability of information they receive. Here we present the evolutionary dynamics of cooperative strategies that are based on social information in the presence of pure defectors and cooperators. To calculate probability estimates of social information, we present a mathematical model based on Bayesian decision making, which allows us to compute probability estimates of cooperative strategies based on available information and social structure.

In this model, in a given round, each individual acts as donor and recipient at once. The donor can cooperate and help the recipient at a cost c to himself, in which case recipient receives a benefit of value b (with b>c). If the donor decides not to help, both individuals receive zero pay-off. Unconditional cooperator cooperates as donor and unconditional defector defects as donor with all other individuals. Whereas social actors use social information in their cooperative strategies against social actors and they cooperate with cooperators and defect with defectors. Social actors compute a decision rule based on Bayesian estimation, which uses the information of unconditional cooperators and defectors in the composition of the population at the time of decision. To capture uncertainty of information, we introduced a reliability parameter, R, which controls the reliability of social information. The parameter quantifies the probability that a cooperator knows as cooperator and defector knows as defector. By using population composition and reliability parameter, we compute cooperative probabilities of social actors. Individuals in the game interact according to the standard iterated Prisoners Dilemma (IPD), after each generation strategies are updated according to the payoff gained in that generation. The fitness of a player is given by the total number of points gained in the game. At the end of each generation, players leave offspring in proportion to their fitness relative to the population fitness. The standard replicator dynamics is used to update strategies after generation.

By varying population structure, that is by varying the number of different category of individuals and by varying the reliability of information, we studied evolution of different strategies by using replicator dynamics. For R >1, probability of cooperation represents true composition of population, for R < 1 probability of cooperation does not represent the population composition and for R = 1 there is no information known about population structure. We study dynamics of cooperative strategies in the following conditions: (1) When the number of cooperators, defectors, and social actors are the same. In this case, for R>1 and R<1, the system reached unique equilibrium with the social actors strategy. (2) When the number of cooperators is more than the other two, for this case, R >1 there exists a mixed strategy with unconditional cooperators and social actors and for R<1 system reaches unique social actors' strategy. (3) When the number of defectors is more than the other two, for R>1 there exists a unique equilibrium of social actors strategy and for R<1 there exists a mixed equilibrium strategy of cooperators and social actors. (4) When the number of social actors are more than the other two, for R >1, there exists a unique equilibrium for social actors strategy, and, for R<1, there exists a mixed equilibrium strategy of social actors and cooperators. The above four conditions the s values are positive and finite numbers. In the case of very large positive value of R (R = Infinite), i.e., perfect information scenario, there is an interesting dynamics take place. If number of

social actors more than the sum of other two and with cooperators more than defectors, the dynamics reach to mixed strategy of social actors and cooperators, whereas, interestingly, for the number of defectors more than number of cooperators there exists a mixed strategy of social actors and defectors. Unlike standard results reported in the evolutionary models of cooperation, our simulations revealed stable strategies for unconditional cooperators. The existence of these strategies could possibly due to the presence of altruism in the population when social information is available and used by a sub-set of the population (social actors).

Global-local processing is influenced by irrelevant emotional processing: An ERP study using the odd ball paradigm

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Recent studies have begun emphasizing the close and reciprocal relationship between emotion and attention. We have earlier shown that distributed attention or global processing is linked with happy emotion recognition and focused attention or local processing with sad emotion recognition. Happy faces presented on the background are identified better than sad faces presented on the background when people performed global processing. The effect reverses with local processing where face identification is better with sad faces presented on the background. So far, we do not have a clear picture of the neural mechanisms involved in this link between scope of attention and emotion perception.

Hence, we performed an event-related potential (ERP) study in which we manipulated the scope of attention using hierarchical letter stimuli and emotional content of the face (happy or sad) in the background. We also manipulated the frequency of occurrence of the emotional content when participants performed global or local processing. In each block, one emotional face (frequent) was presented 80% of the time and the other one (deviant) 20% of the time. There were two global and two local processing blocks. We expected interaction between global-local processing and emotional content. We also expected that there would be frequency effect for happy faces in the global condition and sad faces in the local condition. Nineteen volunteers participated in the experiment. Each block contained 300 trials and a total of 1200 trials in the experiment. Each stimulus was presented for 200 ms with an inter-stimulus interval range between 500 and 700ms jitter time for a fixation. Participants identified target numbers (“6” or “9”) that appeared at the global or local levels, while ignoring the irrelevant emotional face on the background. We analyzed the ERP waveforms for the target local and global stimuli, focusing on early P100 (66-150), the late P300a (215-315ms) and P300b (315-370ms) components especially at the anterior frontal, prefrontal, frontal, central and centro-parietal regions.

Our ERP results indicated a significant main effect of emotion revealing higher amplitude in the sad face condition compared to the happy face condition in the P100 component at the prefrontal, anterior-frontal and frontal regions. In this early component, the main effect of the scope of attention was significant in centro-parietal region yielding higher amplitude for local than the global scope of attention. Significant interaction between the scope of attention and the emotion was present in the early P1 component at the centro-parietal midline electrode (Cpz); amplitudes were higher for happy-local and sad-global compared to happy-global and sad-local conditions respectively.

The three way interaction between the scope of attention, emotional expression and the frequency of occurrence was significant with the late component of P300b (315-370ms), showing a significant difference between frequent and deviant conditions for the global-happy condition in the frontal region. The difference between frequent and deviant conditions for the local-sad condition was significant only in the right hemispheric anterior-frontal regions.

Our ERP results suggest that the changes in scope of visual attention during global and local processing occur much earlier (i.e., P100) than the N1 component, which has been indexed in previous studies. For the first time, our results documented neural indicators for an interaction effect between the scope of attention and emotional expressions. The results provide not only neural evidence for the link between scope of attention and emotions but also for the time course of those interaction effects.

The Perception of Emotion in Eastern Music: A Study on North Indian Classical Ragas

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It has been well documented in ancient literature of India that Ragas or a specific combination of notes are capable of evoking distinct emotions but very few attempts have been made to investigate this phenomenon. The primary objective of this study was to conduct a behavioural survey to investigate emotional responses to different North Indian Classical ragas. It had three objectives (1) to characterize emotional responses across different ragas and to compare responses across different cultural populations (2) to compare emotional responses across two primary presentation modes namely alaap and gat. Alaap is a slow arrhythmic composition while gat is faster and rhythmic. (3) to study the effect of tonality on emotional responses.

Three minute instrumental renditions of twelve ragas composed in alaap and gat were digitally recorded by a professional musician on sarod (a stringed musical instrument). Ragas were chosen to induce both positive and plaintive emotional states. Participants listened to excerpts online (http://emotion-in-music.nbrc.ac.in/p1/) and rated each piece on a four point Likert scale for eight emotions belonging to positive and plaintive categories namely: happy, romantic, devotional, calm, angry, yearning, restless and sad. Emotional responses from 251 participants (Indians-55.8%, Non-Indians-43.8%) were analysed. Our results indicate (1) a robust positive correlation between intended and perceived emotion of the raga that was independent of culture. (2) An effect of rhythm on emotional ratings. For instance, responses of ragas that were rated as ‘calm’ during Alaap shifted to ‘Happy’ when played in Gat. Similarly, ragas rated as ‘sad’ in Alaap shifted to ‘Yearning’ or ‘Restless’ in Gat. 3) The presence of specific major and minor pitch intervals was predictive of positive and plaintive responses. The percent mean frequency of occurrence of major sixth (shuddh dha) and major seventh (shuddh Ni) explained 64% of variance for ‘happy’ responses while that of minor second (komal Re) and minor sixth (komal dha) explained 79% of variance for ‘sad’ responses. Our results therefore suggest that both rhythm and tonality influence emotional response to North Indian Classical ragas.

Scope of Attention Modulates Outcome Processing in Decision Making Under Risk: An ERP Investigation on Medial-frontal Negativity

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Recent literature has emphasized the influence of scope of attention on various cognitive and affective processes including emotions and decision making. The studies, in general, point towards a putative link between emotion and scope of attention. Identification of happy faces or positive emotions is associated with global processing and that of sad faces or negative emotions is associated with local processing. Emotions which are irrelevant to decision making task, have also been found to affect choices and post-choice experience. Given that incidental emotions influence post-decision processes, we investigated the influence of scope of attention on such post-decision processes. Earlier ERP studies have shown larger amplitude of medial frontal negativity (MFN) in fronto-central region for losses compared to gains. In addition, our previous ERP experiments, using similar gambling paradigm, showed that incidental happy/pleasant emotions modulate the post-decision experience compared to neutral and sad/unpleasant emotions. We found that the MFN amplitude difference between loss and gain to be modulated by happy/pleasant context, but not by neutral and sad/unpleasant contexts. In the current study, we conducted an ERP experiment to explore how scope of attention (global and local) influences the affective experience (regret/rejoice) of the outcome (loss or gain) in a gambling task. Based on our earlier findings and the link between global-local processing, we expected a significant interaction between scope of attention and outcome with respect to MFN amplitude in the medial-frontal area. We specifically expected a greater MFN amplitude difference between win and loss for global processing style compared to local processing style. We adopted a modified regret paradigm with monetary incentives. Scope of attention was manipulated using hierarchical stimuli (either H or S), which appeared for a short duration between two gambles presented in 2AFC. Participants had to select one of the gambles after which they were shown the outcome of the chosen and the non-chosen gambles. After that, participants were asked to rate their experience on a scale ranging from -15 to +15. At the end of each trial, participants were asked to report the identity of the hierarchical stimuli (H or S) either at global or local level. The ratings revealed a significant effect of outcome, with rejoice ratings being significantly higher in magnitude compared to regret ratings. ERP analysis was performed on the 300-340ms time window from the onset of revealed outcomes. The mean amplitudes for MFN at Fz showed a significant effect of outcome with larger amplitude for loss compared to gain. The interaction between scope of attention and outcome was also significant at Fz. Post hoc results showed significantly larger amplitude for loss compared to win for the global condition. Studies have speculated that mechanisms for happy emotion and global level of processing share common resources. The results from the current study for global level of processing match our earlier results which show similar MFN activity for outcome experience in happy/pleasant emotional context. We suggest that the global scope of attention increases the expectation of gain from the outcome which leads to a higher negative reward prediction error for loss and lower positive reward prediction error for gain in global compared to local condition.

ERP Correlates of Task Relevant Affective Conflict Monitoring and Adaptation

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Most of the research on affective conflict monitoring and adaptation has focused on the dissociation of cognitive and affective control processes. While previous studies have indicated that proactive control processes could be modulated by task irrelevant emotional stimuli, there is still no evidence of proactive control with task relevant emotional stimuli and whether it would vary across emotions. Secondly, since the adaptation effects have been extracted as a function of previous trial effect it would be interesting to look at the temporal dynamics of this effect by using EEG/ERP. ERP studies on conflict adaptation have demonstrated changes in latency and amplitudes correlated with the reduction in Stroop effect as a function of proactive control. However, so far ERP studies on affective conflict adaptation have not been attempted due to the small magnitude of such effects. We examined proactive control effects in the context of task relevant positive and negative facial expressions as a function of previous and current trial congruence on a face-word Stroop task. Participants identified the facial expression, happy or sad in experiment 1 and happy or angry in experiment 2 expressed by a face that either contained the word happy/sad or happy/angry. Mean reaction times and ERP amplitudes were analyzed to look at the interaction among target emotion, current trial congruence, previous trial congruence, and previous trial emotion. We found a stronger conflict adaptation effect for sad faces as a function of previous trial emotion whereas it was comparable with happy facial expressions when analyzed as a function of previous trial congruence. These effects were found to be completely reversed for angry facial expressions when compared to happy expression. We also observed a greater reduction in ERP amplitudes of the N200 component at the FCZ electrode site on high conflict trials for negative emotions as compared to positive emotion suggesting stronger conflict adaptation effect for sad and angry faces. N200 not only depicts conflict monitoring but also adjustment in control. Proactive control seems to be more successful with sad/angry faces. In addition, both arousal and valence might be important to understand the interaction between emotions and proactive control. Moreover, previous studies based on task irrelevant emotional stimuli have shown that negative emotions impair conflict driven control, though we find that task relevant negative emotions seem to influence proactive control mechanisms.

Effect of proficiency on the proactive inhibitory control among Hindi-English bilinguals: An ERP study

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Cognitive control is required to maintain goal oriented behavior. Reactive and proactive modes of control aid in avoiding interference or undesirable responses in order to accomplish a goal. Studies have demonstrated executive control advantage among bilinguals as compared to monolinguals as well as a function of second language proficiency using various control tasks. A few studies have also looked at response inhibition and goal oriented behavior among bilinguals as compared to monolinguals. However, preparation for goal oriented behavior in the face of response conflict in terms of the activation of proactive control mechanisms as a function of proficiency is yet to be well understood. We compared Hindi-English high proficient and low proficient bilinguals on a cued Go/No-Go task using behavioural and ERP data. Proficiency was assessed using the language background questionnaire, LEXTALE in English and picture naming and picture description tasks. We hypothesized that high proficient bilinguals would show greater involvement of proactive control on a goal oriented cognitive control task in comparison to low proficient bilinguals and high amplitude in N200 component for high proficient bilingual. It was expected that the two groups would show a difference in reaction times and ERP amplitudes as a function of the proportion of Go/No-go trials and cue suggesting the likelihood of the occurrence of the go/no-go trials. EEG/ERP was recorded using the 128 channel EEG system (EGI). Modulations in the amplitudes and latencies of the N200 components were analyzed as a function of cue and probability of Go/No-Go trials. Reaction times were compared for ‘Go’ trials across three probability conditions (proportion of Go/No-Go trials) and two cue types (certain cue and ambiguous cue) between high and low proficient bilinguals. High proficient bilinguals were generally faster than low proficient bilinguals. Both high and low proficient groups performed differently across the three probability conditions and for both cue types. The interaction between group and cue type showed a trend of significance. ERP data was analyzed to look at the changes in amplitude and latency of the N200 component at frontal and frontal central sites which showed a significant interaction between proficiency and probability of Go trials as well as between proficiency and cue. High proficient bilinguals showed larger amplitudes for the N200 component for the go trials for the ambiguous cue type and when the probability of No-go trials was less as compared to the trials with higher probability for No-go trials. In addition, under the high monitoring condition with equal probability of go and No-go trials high proficient bilinguals showed greater N200 amplitudes as compared to low proficient bilinguals. These results indicate that high proficient bilinguals may show a greater involvement of the proactive control mechanisms in the face of uncertainty and in case of high monitoring condition.

Effect of Language Proficiency on the Processing Cost associated with Language Switching

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Keywords: Language Switching, Language Proficiency, Inhibitory control model, Processing cost

Language switching has become an inevitable ingredient of bilingual discourse. Recent experimental studies have provided an insight into the co-activation and interaction of two languages among bilinguals'. Inhibitory Control Model (Green, 1998), postulates that this co-activation results in a competition across languages. Thus, in order to resolve this competition one of the two languages has to be inhibited. The decision as which language will be inhibited lies on the will of the speaker or the contextual cues. Switching from one language to other involves some amount of cognitive cost in terms of increased reaction time and error rate in comparison to monolingual condition. In addition, dominance in a particular language plays a crucial role in the profile of cognitive cost associated with language switching. Studies have also found that when the native language dominant bilinguals switch from native (dominant) language to a non-native (less dominant) language, they require less time than switching from non-native language to their native language. Further, studies have also addressed the problem of balanced bilingualism in this context. These studies report less asymmetrical profile in the context of language switching amongst them. Previous studies assessed language dominance in terms of self-rated proficiency in both of the languages. However, many other latent factors may affect the proficiency in a particular language such as frequency of usage of a language in day to day living and confidence in a particular language. The present study intends to take into account not only the participants self-rating on the reading, writing, speaking, and comprehension but also on the confidence in speaking and understanding and frequency of usage of a particular language.

Hypotheses:

1. Hindi dominant bilinguals would require more cognitive cost in backward switching (English to Hindi) in comparison to forward switching (Hindi to English).
2. Balanced bilinguals would not differ in terms of the cognitive cost in both forward and backward switching.

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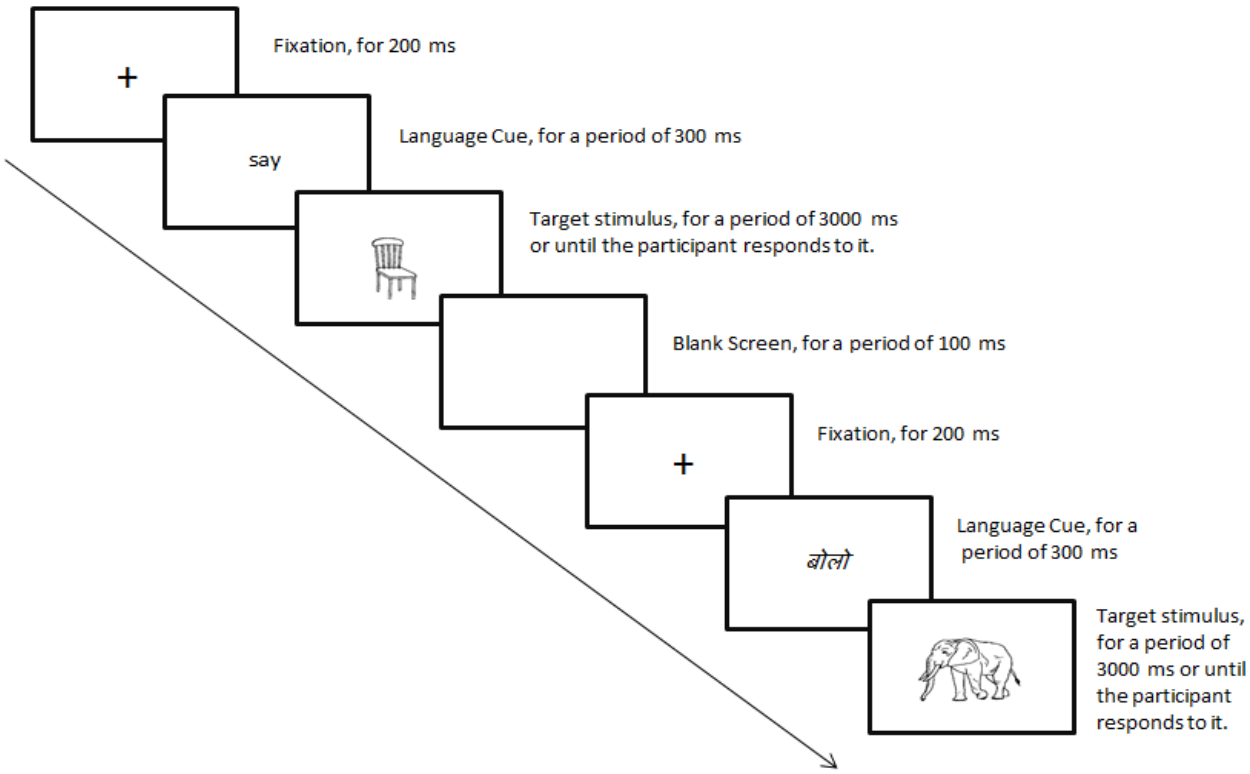
*Research Scholar

**Professor

Method:

Sixteen bilinguals with age range of 23 to 28 years participated in the study. The participants were assessed on the **Language Self-Evaluation Scale (LSES).** This scale requires participants to rate their proficiency not only on the various aspects of language (like reading, writing, verbal and comprehension) in general, but also in varied day to day activities. LSES also provides subjective rating on the frequency on language usage by the participants, in various contexts. **Cued Picture-naming task** was used to examine the cognitive cost associated with language switching. The task was developed using Superlab Software version 4. Cedrus voice key was used to record the voice onset reaction time (VoRT) of the participants. The audio file of the responses were also maintained using an external microphone in order to later check the accuracy of the response. The stimulus involved ten line drawings which were to be named by the participants on the basis of the language cues. In the task, a single trial constituted of a fixation cross, then the language cue, which could be either *बोलो* or say was followed by the presentation of a line drawing. The participant was required to name the picture as soon as it was flashed over the computer screen. When the word *बोलो* was flashed the participant were required to name the line drawing in Hindi while when the word say was flashed the participant were required to name the picture in English . The picture disappeared from the computer screen as soon as the participant responded to it. After the participant responded to the picture, a blank screen was flashed over the computer screen. The whole experiment involved 600 trials. The participants were provided short rest pause of five sec after every 20th trial and a long rest pause of 30 sec after every 200th trial.

The Pictorial description of the task is depicted below:



Design:

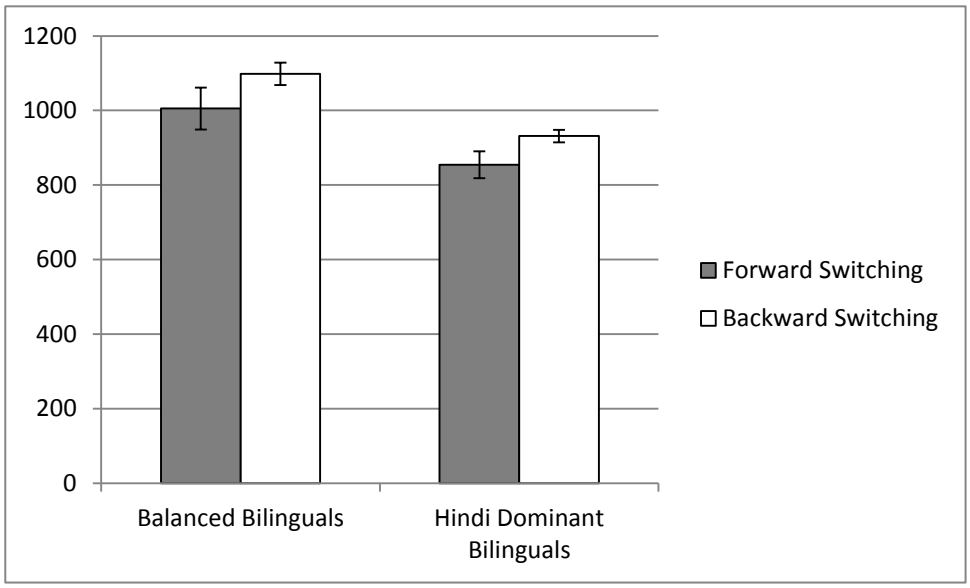
A 2 (Proficiency: Hindi dominant bilinguals and Balanced bilinguals) × 2 (Transition: Hindi to English, English to Hindi) mixed factorial design with repeated measures on the last factor was employed.

Results:

Table 1: Mean and SD of Hindi dominant and balanced bilinguals against transition

Proficiency	Transition	
	Forward Switching Mean (SD)	Backward Switching Mean (SD)
Hindi dominant bilinguals	854.32 (52.45)	931.30 (95.54)
Balanced bilinguals	1005.11 (101.16)	1098.14 (159.26)

Figure 1: Mean reaction time of Hindi dominant and balanced bilinguals against transition



The main effect of proficiency yielded an F ratio of F (1, 7) = 9.481, p = .018, indicating that the mean change score was significantly greater for balanced bilingual group (M = 1051.63, SD = 113.43) than for Hindi dominant bilinguals (M = 892.81, SD = 73.12). The main effect of Transition yielded an F ratio of F (1, 7) = 13.974, p = .007, indicating that the mean change score was significantly higher in the backward switching (M = 1014.72, SD = 76.21) than in the forward switching (M = 929.72, SD = 61.89). The interaction effect was non-significant, F (1, 7) = 0.075, p = 0.79. Further, t test revealed significant effect of transition for the Hindi proficient bilinguals (t = 4.468, df = 7, p = .003) but not for balanced bilinguals (t = 1.873, df = 7, p = .103).

Discussion:

The present study examined the effect of language proficiency on the processing cost associated with language switching. The results clearly indicate significant mean difference of backward and forward switching among Hindi dominant participants. This finding supports the first hypothesis which stated that Hindi dominant bilinguals will require more cognitive cost in backward switching in comparison to forward switching.

Results further reveal that the mean difference was found non-significant in the case of balanced bilinguals and support the second hypothesis that there will be no significant difference amongst balanced bilinguals in the cognitive cost in forward and backward switching. However, balanced bilinguals required more reaction time in backward switching (M =1098.14) as compared to its counterpart forward switching (M = 1005.11). Thus further research is required in this context.

Overall, the findings of this study clearly indicate that language proficiency does play a crucial role in the context of language switching. Also, higher proficiency in a particular language results in asymmetry in the switching profile.

Neural Correlates of Language Proficiency in Trilinguals: An fMRI Study

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Multilingualism is a unique condition in which the brain accommodates and assimilates more than one language. Housing multiple languages within one system raises many interesting speculations regarding its consequences. Past literature on the organisation of multiple languages in the brain has been mixed. While some neuroimaging studies have indicated the recruitment of common neural substrates across two (Abutalebi, 2008; Chee, Tan, & Thiel, 1999), and three languages (Videossott et al; 2010), other studies have reported anatomically distinct activations for native versus later learnt languages (Kim, Relkin, Lee, & Hirsch, 1997). These differences in recruitment of cognitive resources in multilinguals have often been attributed to differential proficiency in L1 and L2 (Perani & Abutalebi, 2005).

Using a picture naming task in three languages, the present study investigated how language proficiency modulates brain activity in multilinguals. A homogeneous sample of 22 right-handed trilinguals varying in age of acquisition in three languages were selected for the study. Participants were native speakers of Bengali (L1),who had acquired English (L2) at age 5, and Hindi (L3) at age 12. Their language background and usage was assessed and verified using an in-house questionnaire. We obtained their proficiency in each language by subjective proficiency ratings on a ten point scale (1= least proficient, 10= highest proficiency) and then objectively assessed the same on the basis of accuracy scores on a constrained word production task. Results of the task revealed highest accuracy in Bengali (85%, SD= 1.75) and similar accuracy in English (83%, SD= 2.96). Accuracy in Hindi (72%, SD= 4.15) was significantly lower than in Bengali ($p = 0.003$) and in English ($p = 0.006$). According to accuracy scores (as predictors of proficiency) and the self-ratings on the proficiency scale Hindi was found to be the least proficient language. In a 3 Tesla Philips scanner the participants then performed a time constrained picture-naming task for each language in separate blocks.

Consistent with the previous literature, we found activations in neural substrates known to be involved in the process of picture naming, namely the occipital areas (BA19,18), temporal and hippocampal regions (BA38, 20) and the supplementary motor area and precentral gyrus (BA6). This picture naming network was seen for each language, in comparison with the baseline when assessed at $p<0.05$ (corrected) . A visual inspection of the regions of activity showed an inverse correlation with language proficiency in the left fronto-temporal areas. In addition, the extent of activation in left frontotemporal areas was highest for Hindi, the language of least proficiency in contrast to other languages. These findings corroborate well with previous evidence (Abutalebi, 2008; Kim et al., 1997; Videsott et al., 2010) that have reported higher activation in the same regions for a language of lower proficiency in a given sample.

Further analysis will focus on direct subtractions across languages to identify regions associated with language proficiency and quantifying differences in BOLD brain activity across the three languages.

Body Parts and Early-learned Verbs in 4-year-old Telugu Speakers: A Cross-linguistic Comparison in Association

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Traditionally, the perspective has been that the meaning of verbs differs importantly across languages, particularly since Talmys' study on verb dynamics in adults (1975), but also in children from diverse linguistic provenance (Bowerman, 1985; Clark, 1993; Maratsos & Choakely, 1980, Slobin, 1996). Recently, however, growing evidence in neuroimaging studies mostly in Indo-European languages, but now in Chinese3, indicates that verb meaning processing engage the activation of regions of the motor system and particularly regions related to bodily effectors, a result also available for 4- to 6-year-old speakers of English (James & Maouene, 2009). Further, some systematic associative studies on body parts and common verbs in English Adults speakers (Maouene, Hidaka & Smith, 2008), and in their 4- to 5- year-old counterparts (Sepsey, Nesheim, Maouene & Maouene, 2011) as well as in adult Telugu, Urdu, Hindi & L2 English speakers (Duggirala et al., 2011) indicate some semantic similarities in the patterns tying verbs to the body regions of mouth, leg, arm, although only 65% of the verbs were comparable in meaning. Consequently, we wondered whether the results found for English speaking children would hold true for Telugu speaking children and how they would compare in terms of cross-linguistic similarities and differences.

The 124 early-learned verbs examined here came from 30 transcripts of 18- to 36-month-old Telugu speakers and encompassed all the 103 action words included in the MCDI norms for young English speakers (Fenson et al., 1994). Subsequently, in a judgment task, 42 four-year-olds from a Hyderabad elementary school, were asked orally and individually: "What body part do you use when you _____" . In total, the children provided 21 distinct body part terms. From these judgments, we created a body-part vector for each verb. For example, the "meaning" vector for మాట్లాడు (=speak) is: 39 mouth, 2 teeth, 1 lips).

A correspondence analysis (~ a dimension reduction technique for categorical data, sensitive to correlation but respecting variance) on the matrix of 124 verbs by 21 body parts revealed a highly systematic and structured pattern. The first five dimensions accounted for 94.8% of the judgments and correspond to Dimension 1: hand-region-verbs (68 verbs); Dimension 2: mouth-region-verbs (27); Dimension 3: leg-region-verbs (14); Dimension 4: eye-verbs (3); Dimension 5: ear-verbs (2). These dimensions match the ones found for similar verbs in 50 adults English speakers and in 10 four-to-five year old English speakers but they account for proportionally more of the judgments (roughly 10% more), although only 65% of the verbs were comparable in their meaning. Subsequently, we compared the data thus obtained to the adult data available from Duggirala et al., 2011, for 12 adults (in Telugu, Urdu, Hindi) and for 18 adults in English L2. The four correspondence analyses yield the same 5 dimensions.

Developmental and cultural differences are also reported, such as the reduced numbers of body parts provided (21 body parts in Telugu children, 29in adults), or cultural convention in specific body regions connected with verbs (e.g., fingers but no arms in Telugu children compared to English children, head for nod in Telugu is an important verb).

The presentation will build the case, that despite cultural differences in gesturing, in names we give to the parts of our body and where we set the boundaries a body part refers to (Majid, 2006), evolution—under the laws of physics—has shaped the human body part structure (the head is the top part no matter what it is called, no matter where it starts and where it ends), the degrees of freedom of bodily movements, (you can only bend your knees forwards) and consciousness of bodily efforts (motor control of body parts, such as activation or inhibition) in a somewhat shared way across cultures. This is indeed an imperfect overlap, but a precious one, which may inform the meanings of early-learned verbs across languages. We share some physical human experience that—despite the difference in meaning coming from conventions in the culture—is present in our associations between verbs and body parts.

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Performance Monitoring and Response Inhibition in a Saccadic Countermanding Task in High and Low Proficient Bilinguals

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One of the crucial aspects of bilingualism that sets bilinguals apart from monolinguals is their daily experience of handling two languages. Not only the two languages get activated in parallel, even when only one language is needed, but also requires constant monitoring and attentional control to select the goal appropriate language. As a consequence of this daily activity lead to enhancement and strengthening of general purpose executive functions, in particular inhibitory control, which are believed to be recruited in controlling the two languages. Owing their superior control abilities bilinguals have outperformed their monolinguals counterparts on wide variety of task requiring conflict resolution, monitoring, switching, and inhibitory control. While much research has been directed at the interaction between lifelong bilingualism and executive control, a few studies have looked at the consequential effect of bilingualism on performance monitoring. In the present study we examined whether response inhibition and performance monitoring within the oculomotor domain is affected by language proficiency in bilinguals. To this end, we compared high and Low proficiency bilinguals on two forms of oculomotor redirect tasks: Visually Guided Redirect task (Experiment1) and Memory guided Redirect task (Experiment 2). Using switch reaction time (TSRT) and non-cancelled saccades as a measure of response inhibition and post stop slowing as measure of performance monitoring, we observed two important results. It was found that High proficiency bilinguals showed more post stop slowing on the no-step trials as compared to the Low proficiency bilinguals for both VGR and MGR. Secondly, high and low proficiency bilingual exhibited comparable TSRT and non-cancelled saccades, in both VGR and MGR. In the light of these results, we conclude that bilingualism impacts performance monitoring which is modulated by language proficiency. Thus, indicating towards more cognitive flexibility and superior ability to adjust behaviour in high proficiency bilinguals that facilitates attainment of cognitive goal. However, language proficiency showed no altering effect on the response inhibition in bilinguals.

Cognition and Cuiure: Testing Semantic Memories in Indian Patients

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Semantic memory is a part of our long term declarative memory that abstracts and stores information from the world around us. As a result, our semantic memories are impacted by our culture, i.e., the customs, attitudes, characteristic features of our everyday existence. Therefore, any test of semantic memory needs to reflect these aspects of culture and cognition of the person/populations being tested to be effective. Semantic memory deficits are seen in a wide range of neurodegenerative diseases (from Semantic Dementia (SD), Progressive non-fluent aphasia (PNFA), Alzheimer's disease (AD), behavioral variant of Fronto-temporal Dementia (bvFTD), etc.), and the profile of deficits varies significantly across these disorders. However, most of the tests that we use in India assess cognition as a whole, only superficially examining semantic memory. In addition, most of the tests of semantic memory have a high language component, and as a result make it challenging to distinguish between language impairments masquerading as semantic memory deficits or true semantic memory deficits. While it is impossible to have a test of semantic memory that is completely independent of language, we can attempt it by testing semantic memory using different input (i.e., visual/auditory/tactile) and output modalities (i.e., verbal/non-verbal). Recognition of these phenomena are important in the differential diagnoses of cognitive disorders, as well as in understanding and explaining the patients' difficulties at a practical level. The Cambridge Semantic Test battery is one such battery that assesses semantic memory deficits using different input/output modalities.

In this paper, we present the Indian Semantic Battery which is an adaptation of the Cambridge Semantic Battery. Semantic memory is culturally driven and therefore varies across different cultures. Our challenge was to adapt the test battery to make it culturally relevant in India given the diversity in culture, religion, education, language etc. As part of the adaptation process, we present the reasons for changing items to those that were more culturally relevant. In addition, we also present the rationale and need for introducing new categories (vegetables, food items and gods).

We present the results of our adaptation of the Cambridge Semantic Battery to the local cultural context by following the norms of standard cross-cultural adaptations. Necessary modifications were done based on expert committee recommendations and results of pilot studies were analyzed to reach a consensus regarding the items finally included in the Indian semantic test battery. Construct validity was established as we found that SD patients have significant impairments on the semantic memory test battery when compared to controls. In addition, a comparison of test performance was done across SD patients and three other dementia subtypes i.e. AD, PNFA, and bvFTD. Our results found that these four groups of patients have different/varying profiles of semantic memory deficits.

This is the first study from India to adapt and validate tests of semantic memory to the Indian context. This test of semantic memory adapted to the Indian context, may provide objective and sensitive evidence of semantic impairments enabling the clinician in diagnoses and also allowing for more targeted and effective cognitive retraining/rehabilitation. In conclusion, we would like to claim that for any test of cognition to serve its purpose, it will need to resonate with and reflect the culture of the populations it assesses.

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Title: Laterality in the Iowa Gambling Task: Does sensitivity to rewards-punishment alter regulatory control?

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Introduction and research problem: The right hemispheric dominance observed in decision-making in the Iowa Gambling Task (IGT) is yet to be understood. The task involves rewards and punishments that are processed along the dual routes of intertemporal attributes, reflecting cognition-intensive processing, and frequency attributes, reflecting automatic processing. Drawing from dual process theories and lateralization related to reward-punishment, it was hypothesized that handedness as a measure of laterality would have an effect on regulatory control (defined as a failure of cognition-intensive systems to over-ride automatic processing systems), and that the effect would differ across reward and punishment variants of the task.

Methods and design: The Edinburg Handedness Inventory was used to compare laterality quotients [left-handers (quotient ≤ 50), mixed-handedness (51–99), right-handedness (≥ 100)] and usage of dominant or non-dominant hand (left and right hand) to perform the IGT in two variants (reward and punishment) ($N = 320$, males = 160). Decision-making scores were entered into a 2 (attribute: intertemporal/frequency) × 2 (hand recruited: left/right) mixed-design ANOVA, analyzed for three groups (handedness: left/mixed/right); variants were analyzed separately.

Results and discussion: In the reward variant, the effect of attribute was significant across all three conditions of handedness ($p < .05$ for left-handedness; $p < .01$ for mixed- and right-handedness), although the interaction effect of attribute and hand recruited was insignificant ($p = .09$ in mixed-handedness). In the punishment variant, the effect of attribute as well as the interaction effect of attribute and hand recruited were insignificant across the three groups. As expected, lateralization of regulatory control reflected in the effect of attribute type showed differential effects of hand recruitment in variant type across conditions of handedness.

Left eye – Right Brain: Exploring the Impact of Social Isolation on Personality Traits and Lateralized Utilisation of the Brain in an Air-breathing Freshwater Fish

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Fish have laterally positioned eyes that provide a very narrow frontal vision overlap while the axons of each eye connect only to the contralateral brain hemisphere. The fish brain thus receives exclusive information from each eye. This neuro-anatomical uniqueness, expressed as differential eye use while assessing different visual stimuli, makes fish an excellent model system to study the relationship between cerebral and behavioural lateralisation. Recent studies have revealed that the variation in the cerebral hemisphere predominantly used to attribute emotive content to a visual stimulus can influence the consistent individual differences in behaviours (personality traits) displayed by a fish. An analysis of the relationship between personality traits and the differential use of cerebral hemispheres in fish has, however, only rarely been explored.

Our study analysed the degree of differential utilisation of the brain hemispheres by an air-gulping freshwater fish, the climbing perch Anabas testudineus, while assessing isolated conspecific individuals, heterospecific (tilapia Oreochromis mossambicus) individuals, shoals or groups of four conspecific or heterospecific individuals, a mirror and a novel object. We also explored the possible existence of a behavioural syndrome consisting of (tight correlation between) the lateralised utilisation of brain hemispheres and two major personality traits, sociability (the tendency to spend time with conspecific or heterospecific individuals) and boldness (the propensity to take a risky decision). Finally, the impact of social isolation (for 150 days) on these three focal traits and the resulting possible correlations between them were also investigated during this study.

Our results reveal that the group-living individuals exhibited a general bias for their left brain hemispheres while assessing all the stimuli presented, except isolated and groups of conspecific individuals. In contrast, the socially isolated subjects exhibited a bias for the right eye while evaluating solitary or a shoal of heterospecific individuals. A cross-context comparison of laterality revealed that a shoal-living fish preferentially used its left hemisphere while observing a single heterospecific individual, in direct opposition to its use of the right hemisphere for isolated conspecific and shoals of conspecific or heterospecific individuals. Socially isolated individuals, however, exhibited differential laterality only in presence of a solitary heterospecific individuals or a novel object. Group-living fish, in general, exhibited significant individual-level variation in the lateralised utilisation of their cerebral hemispheres while assessing solitary heterospecific individuals, mirror images and novel objects while socially isolated subjects displayed a similar result only in the presence of novel objects. When the sociability of climbing perch was investigated across contexts, group-living fish significantly preferred to spend time close to shoals, whether conspecific or heterospecific, than to solitary individuals of any species. The sociability exhibited by these individuals towards conspecific or heterospecific shoals was, however, not different from that displayed towards the mirror. In contrast, socially isolated fish spent significantly less time in the vicinity of isolated conspecific individuals than they did close to conspecific or heterospecific shoals, isolated heterospecific individuals to even the mirror. Moreover, it is noteworthy that social isolation led to altered patterns of sociability in the study species, with socially isolated individuals significantly increasing the time spent close to solitary conspecific or heterospecific individuals or novel objects (but not to shoals of any species) over that displayed by individuals reared socially.

The personality trait, boldness, displayed by climbing perch was uninfluenced by social separation, with boldness, sociability and the lateralised utilisation of the brain hemispheres failing to display any significant correlation amongst one another in socially isolated subjects. There were, however, positive correlations between the time spent near heterospecific shoals and boldness as well as between laterality and time spent near novel objects, but only in the case of group-living subjects. These results are significant and merit serious attention in the light of recent studies analysing the relationship between personality traits such as sociability, behavioural decision-making and cerebral lateralisation in other animal species.

The Effect of i-extract Treatment on Activity Regulated gene (Arg3.1) Expression and Behavioural Consequences in Scopolamine-induced Amnesic Mice

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The brain is a complex organ which performs a range of cognitive functions including learning and memory. Amnesia is a cognitive disorder during which some kind of brain damage, disease or trauma causes a deficit in memory. In laboratory conditions, it can also be caused temporarily by the use of various psychoactive or sedative drugs. Scopolamine, a tropane alkaloid drug, possesses anti- muscarinic effect and therefore disrupts cholinergic neurotransmitter system of brain. We generated scopolamine induced amnesia in Swiss albino mice of 12±2 weeks and tried to study the effect of i-Extract i.e. alcoholic leaf extract of Ashwagandha (Withania somnifera) on the expression of activity regulated gene Arg3.1 (also known as Arc) in mouse brain.

Briefly, mice were categorized into 5 groups and treated with (1) 0.9% saline (i.p.), (2) amnesic drug scopolamine (i.p.), (3) scopolamine followed by i-Extract, oral, (4) i-Extract alone, and (5) i-Extract followed by scopolamine. The drug treatment was continued for 7 days along with the daily assessment of their spatial memory through Morris water maze test. Thereafter the mice were sacrificed and cerebral cortex and hippocampus were dissected out for the analysis of gene expression.

We found that scopolamine downregulated the expression of Arg3.1 both at mRNA and protein levels. Pre treatment with i-Extract was more effective than post treatment in attenuating the scopolamine mediated decline. Significant correlation was observed between Arg3.1 expression and spatial memory of mice during amnesia and its restoration. Interestingly, the effect of scopolamine and i-Extract was relatively more conspicuous in hippocampus than cerebral cortex. In conclusion, our study provides evidence for the upregulation of neuronal plasticity gene by Ashwagandha i-Extract suggesting its curative potential for memory deficits.

Language, culture and education in cognitive disorders

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With an increase in life expectancy, future demographic projections predict a larger population over the age of 60 years with a corresponding increase in the number of patients with dementia and other cognitive disorders. Hitherto considered infrequent, dementia and other cognitive disorders are increasingly being recognised in clinical practice in India, especially in cities. Developing societies have particular problems in understanding diseases of cognition as they make the change from traditional to modern living. There is poor awareness, scarcity of trained personnel and a lack of validated neuropsychological tools that makes the problem more daunting. The complexity of the task increases when we take into consideration the diversity in culture, education and rural/ urban variation across India and the influence of these factors on expression of cognitive disorders, on their diagnosis and management. Thus strategies that focus on understanding, diagnosis and management of cognitive disorders are high priority research and healthcare objectives

Accurate diagnosis and understanding of neurobehavioural disorders depends upon identifying cognitive deficits that include impairment of attention, episodic and semantic memory, executive function, language, visuospatial functions and their functional impact on day to day life. Recent understanding has also brought out the role of social cognition in the genesis of abnormal behaviour in cognitive disorders. While cognitive functions and behaviour are universal, they are expressed and recognised in different ways based on the socio-cultural practices of the community in which an individual lives. Most of the currently existing tools have been developed in the west, and aim at eliciting cognitive deficits in their own populations. Since performance on cognitive tests is strongly dependant on educational levels, languages used and cultural backgrounds, tools developed in one particular population designed to measure cognition and behaviour may not necessarily translate to another cultural context.

Neuropsychological testing for domains of episodic memory, attention, executive function, language and visuospatial functions across a range of languages, education and cultures has been the focus of research across the world. In this talk, we present the challenges involved in studying cognitive functions across different educational levels, languages, and among bi/multilinguals. The additional challenges that are posed while studying semantic memory and social cognition, both of which are impacted strongly by cultural influences will also be discussed. Our experience with harmonising neurobehavioural research in

a population derived from five states of India, with a large degree of heterogeneity in literacy, languages and culture; and variability in skill levels of personnel will also be presented.

Yet another recent dimension is that many studies have demonstrated an association between education, bi/multilingualism and social activity and better cognitive functioning. The interaction between such lifelong experiences and neurobiological and genetic factors is an active field of research. Our recent observations on the role of these factors on impacting age of onset and expression of dementia and cognitive disorders will be presented. As a consequence, a pressing need has emerged to study mechanisms by which education, bi/multilingualism, and other lifelong experiences shape cognitive processes and their underlying neural substrates. Future multidisciplinary studies are likely to unearth ways in which these influences affect cognitive processes and their breakdown in disease.

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A pilot study evaluating efficacy of sung vs. spoken speech to facilitate social attention and communication in children with Autism Spectrum Conditions

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Background: Children with Autism Spectrum Conditions (ASC) experience significant impairments in social and communication development which have been shown to improve with early intervention efforts. Although the research so far has primarily concentrated on deficits in the speech and social communication domain, recent behavioural studies have provided evidence for preserved or enhanced musical abilities in ASC (Heaton, 2012). At the same time, there has been an increasing interest in the use of music for rehabilitation in various neuro-cognitive disorders, with a special emphasis on improving socio-communicative responsiveness in children with ASC (Accordino et al, 2007, Wan et al, 2011). Recent neuroimaging studies on children with ASC have shown robust engagement of the auditory cortex to sung speech as compared to spoken speech stimuli [Lai et al, 2012; Sharda et al, 2013 (under review)]. This suggests that the use of sung speech may be beneficial for children with ASC not only as a tool for learning social engagement and emotional-cues, but also as a neural 'back door' for improving social attention and communication.

Objectives: The aim of the current study is to investigate the behavioural salience of sung speech as opposed to spoken speech on attention, engagement and responsiveness in existing treatment programmes for children with ASC.

Methods: 14 children aged 3-5 years, diagnosed with or at risk of having Autism Spectrum Conditions, have so far participated in this ongoing study. The diagnosis of ASC has been made using DSM V and/or ICD-10 criteria. A detailed questionnaire was used to acquire background information regarding family and medical history and developmental milestones of each child. Participants undergo a thrice-a-week, 12 week long intervention programme (36 sessions) administered by a team of qualified therapists in a clinical setting. The programme includes two parts; Part I is integrated in group sessions and Part II is integrated in individual sessions. In Part I children are passively exposed to videos with sung or spoken narrative content Part II includes eliciting active responses to spoken and sung forms of distinct categories of verbal directives delivered by therapists.. These sessions are video-recorded for post-hoc observational coding of metrics like joint attention, eye gaze, orienting, repetitive behaviour etc. by blind raters.

Results: Data collection is in progress. Preliminary data indicate increased engagement and responsiveness to sung stimuli in children with ASC based on assessment and analysis of observational videos. These preliminary findings are encouraging and suggest that music may be effective in improving attention and communicative function in ASC.

Conclusion: The outcomes of the study will be instrumental in establishing the efficacy of using song and music-based approaches to improve social attention and communication in children with ASC and provide a framework for developing effective therapeutic interventions.

Task Switching in Bilinguals and Multilinguals

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Current literature on bilingualism suggests that the bilingual speakers, who use two languages or frequently switch between two languages simultaneously, have a comparatively better executive control on a switching task than the monolingual speakers. However it would be interesting to investigate whether trilinguals would demonstrate superior cognitive control as compared to bilinguals. To investigate this issue, present study compared the performance of 16 bilinguals (Hindi-English) with 16 trilinguals (Bengali-English-Hindi) in a non-linguistic task switching paradigm. Switching is associated with attentional set shifting as well as cognitive flexibility and these processes have a greater scope for improvement in case of trilinguals as compared to bilinguals. It was hypothesized that the trilinguals would show lesser switch cost and mixing cost as compared to the bilinguals due to their greater trilingual experience with respect to language switching. This hypothesis was based on the premise that it is the language control mechanisms that determine the cognitive advantage observed among bilinguals which are assumed to be strengthened among multilinguals. Screening measures included Lex TALE, which was administered to assess proficiency in the second language; Language History Questionnaire to acquire information about the language use exposure and self rated proficiency in the languages known to the participant and Self-switching questionnaire to determine whether the two groups are comparable in frequency of switching between languages. The task in this experiment involved making a color or a shape judgement based on the previously presented cue. Two types of cues were used: color gradient for the color task and a row of small black shapes as a shape cue for the shape task. Cue (250ms) was followed by the target (2000ms) while the cue remained on the screen above the target. Targets were red and green colored circles and triangles. Participants had to make a color or a shape judgement on the visually presented stimuli, using button press to indicate their selection. Reaction times were compared across switch, repeat and single task conditions. Results demonstrated a reduced switch cost for the trilinguals as compared to the bilinguals. However, mixing cost was comparable for the two groups. These results demonstrate a trilingual advantage in attentional set shifting when compared with bilinguals. These findings extend the bilingual advantage (related to language experience) to trilinguals with respect to mental set shifting.

Reward positivity and Framing in Intertemporal Choice: an ERP Investigation

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Reward positivity is an event related potential (ERP) component associated with reward processing. It shows a positive peak at a latency of 250ms post-stimulus presentation, in the fronto-central region(Fcz electrode). It has also been suggested that Reward positivity reflects the neural activity involved in computation of reward prediction-error i.e., the difference between the expected and the actual outcome. Although, studies haveshown the presence of reward positivity in the context of gains (positive frame) or its role in unexpected outcomes,there is sparse evidence of its role in loss (negative frame). Also, it is not very clear how reward positivity is affected when choices are presented over time (intertemporal choices). The objective of the current study was to investigate the effect of framing in intertemporal choices on reward positivity.For this purpose, we designed an intertemporal choice prediction task in which healthy participants had to select one of the two directions shown on the display which was followed by a feedback. The participants had to make the selection to maximize their gains and minimize their loss. We manipulated the expected utility of the choices (in terms of amount and the temporal duration of receiving the amount) as a within subject factor, and framing (gain frame and loss frame) as a between subject factor.There were four feedback for both gain as well as loss frame. For gain frame, participant either received an amount of Rs.25 or Rs.100 either immediately or after six months.For loss frame,participant had to pay an amount of Rs.25 or Rs.100 either immediately or after six months. We analyzed the EEG data for the Fcz electrode, our window if interest was 250ms-350ms after the presentation of feedback stimulus i.e. outcome. The preliminary results support our hypothesis, that Reward Positivity would be present for gain as well as loss frames.ERP analyses revealed positive amplitude between 250 to 350 ms time-window at Fcz electrode for gain as well as the loss frames. The amplitude of reward positivity averaged across in the loss frame was less compared to the amplitude for the gain frame. Our results, support the earlier studies showing reward positivity for gain frames. But reward positivity for loss frame has not been reported in earlier studies. These results suggest that the neural mechanism underlying reward processing in the domain of intertemporal choice is frame independent.

Modelling the Emotional Influences on Attentional Blink

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Attentional blink (AB) is the attenuation in the detection accuracy of second of two targets (T2) when presented within 200 to 500 ms of the first target (T1) in a Rapid Serial Visual Presentation paradigm. The accuracy of the second target is found to be higher if it immediately follows the first target, a phenomenon known as the Lag 1 sparring effect. Recently, a global workspace theory based neuro-dynamical model of Visual Selection and Awareness (ViSA) has been proposed to explain attentional blink. This model distinguishes between perceptual processing areas and access control areas with the global workspace module and visuo-spatial working memory module forming the access control area. The perceptual processing and access control areas are separated by a gating layer which is modulated by top down signals from working memory and filters inputs based on goal directed top down attention. The model accounts for AB by suggesting that consolidation speed of targets in working memory is the primary cause of the blink effect. Lag 1 sparring is considered to occur due to slow onset of the consolidation process in the working memory.

Many recent findings have shown reciprocal interactions between emotion and attention. In the context of AB, studies have shown that AB diminished by positive affect and task load. Most current models of AB do not explain the emotion-related effects on AB.

The objective of the present study was to augment the ViSA model to account for the role of emotion in selection and consolidation and more specifically the effects of emotion on AB. Studies have shown that higher levels of dopamine in the prefrontal cortex are correlated with positive affect as well as a higher sensitivity of prefrontal cortex neurons in the presence of dopamine.

We postulate that positive affect leads to the activation of dopamine neurons in the Ventral Tegmental Area (VTA) which in turn leads to the increased dopamine levels in prefrontal cortex. Increase in dopamine levels improves the sensitivity of the prefrontal cortex neurons. This increased sensitivity of neurons in the prefrontal cortex, we hypothesize, leads to faster consolidation of the targets in the working memory. This faster consolidation in turn causes earlier opening of the gating mechanism for the second target processing in the global workspace module, attenuating the attentional blink effect.

This postulation was implemented in the model by adding an emotion processing module which identifies the affective content of stimuli and a VTA module which increases the sensitivity of the neurons in the access control area when activated. Simulations show that the presentation of stimuli with positive affect before the RSVP task results in reduction of AB as found in studies by Olivers and Neuwenhuis (2006).

The augmented model also makes novel predictions. We predict that the event related potential component, P3 (which is considered to be an indicator of the working memory consolidation), locked to T1 would have a latency shift with the P3 component occurring earlier in the positive affect condition opposed to neutral or negative. We are currently investigating other emotional effects on AB using the global workspace based model and also empirical work to demonstrate predictions based on the model.

Social Cognition and Frontal Behaviour in the Cultural Context of Indian Healthy and Neurologically Diseased population

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Background: Neurological disorders are associated with a wide range of behavioral problems and each disease is characterized by a distinct behavioral and cognitive profile. Most studies of behavioral abnormalities in neurological disorders are based on Western paradigms. Limited studies exist, that have explored behavioral problems related to theory of mind, empathy, emotion recognition in the Indian context. This has necessitated the adaptation and validation of standardized tests for the Indian context, which will allow cross cultural comparisons and research.

Aims: We aimed to adapt tests of frontal behavior and social cognition to the Indian cultural context and to examine the associations between various cognitive, functional and behavior profiles of dementia patients.

Methods: Study participants consisted of 502 control subjects and 80 dementia patients. Dementia subjects were recruited based on standard diagnostic criteria. Control subjects were enrolled based on appropriate inclusion criteria. Demographic information was obtained in all subjects. Basic cognitive status of patient group was assessed using MMSE and ACE-R which was adapted for Telugu speaking population. Severity of dementia was assessed by using CDR, and neuropsychiatric symptoms were examined with NPI. Impairment in the functional ability of the patient was obtained from the caregiver by using DAD. Caregiver burden, stress, anxiety, depression were assessed with DASS, ZBI. Control and patient groups were matched for age, gender and education levels. Tests of frontal behavior (FrSBe- Frontal Systems Behaviour Scale), empathy (IRI-Interpersonal Reactivity Index), emotion recognition (POFA-Pictures of Facial Affect), and theory of mind (Faux pas test) battery were adapted to the local cultural context.

In the first part of the study, FrSBe, IRI, Faux pas tests were translated to Telugu , and back translated and adapted to the Indian cultural context, following expert committee recommendations. Reliability of results in the control subjects scores were evaluated. As the next step, these tests were validated in FTD patients and compared with healthy controls. POFA-Pictures of Facial Affect was adapted by using standard methods with appropriate changes made to the test stimuli. These tests were then administered in three dementia subtypes i.e. FTD, AD, VaD and their profile was explored. Finally, associations were examined between various variables such as frontal behaviour and activities of daily living and carer burden, empathy and emotion recognition, cognitive scores and frontal behaviour deficits, empathy and carer burden were examined. Appropriate statistical methods were carried out using SPSS 20.0.

Results:

Tests of frontal behaviour (FrSBe- Frontal Systems Behaviour Scale), empathy (IRI-Interpersonal Reactivity Index), emotion recognition (POFA-Pictures of Facial Affect), and theory of mind (Faux pas test) were successfully adapted to the local cultural context by following the norms of cross cultural adaptations. Necessary modifications were done based on expert committee recommendations and results of pilot studies were analysed to come to a consensus of the test adaptations.Internal reliabilities of these tests were found to be good. On validating these tests we found that dementia patients have deficits in frontal behavior, empathy, emotion recognition and theory of mind tests. Our results found that AD, FTD and VaD patients have different profiles of frontal behavioral impairments, and social cognition deficits. Deficits in frontal behavior and social cognitive functions were positively associated with carer burden, depression, anxiety and stress, and were inversely associated with functional ability of the patients.

Conclusions: This is the first study from India to adapt and validate tests of frontal behavior, empathy, emotion recognition,and theory of mind to the Indian context. The profile in these parameters were explored in three dementia subtypes i.e. AD,FTD, and VaD. These tests of social cognition adapted to the Indian context, may give objective and sensitive evidence of impairments of behavior and disturbance of social conduct , which helps the clinician and family members and also society at large to understand and manage the patients.

Future Implications: The tests validated in this study will aid in early and accurate identification of behavioral and social cognition deficits of dementia and its subtypes in a clinical setting, which will help in proper diagnosis and also aid in devising management strategies.

Interaction of Framing and Emotion in Intertemporal Choice

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Intertemporal choices involve trade-offs between the present outcome and future outcome, and one has to choose between a small immediate reward (SIR) and a large delayed reward (LDR). The devaluation of LDR over time is called temporal discounting. Factors like information processing capacity, reference point and emotion affect discounting making it a complex interplay between present temptations and decision outcomes.Rate of discounting is affected by the experience of emotion producing contrary effects to people's expectations. The appraisal-tendency theory states that emotion evokes specific appraisals which have carryover effects specific to decision context. Framing effects show that the discount rates for losses are lower than the discount rates for gains and is called the sign effect or gain-loss asymmetry. The aim of this empirical study is to explore how the interplay between emotion and framing shapes choice of delayed rewards and discounting behaviour. Firstly, we hypothesized that pleasant emotion would facilitate the choice of larger delayed reward (LDR) and the unpleasant emotion would facilitate choice of smaller immediate reward (SIR) thereby affecting the discounting functions.Secondly, we predicted that people will discount future reward more in gain frame compared to loss frame. The independent factor emotion had three levels (pleasant, neutral, and unpleasant) along with three reward levels (small, medium, large). Same intertemporal choice gamble set was presented in both the frames i.e. gain and loss. On each trial, the participants were presented intertemporal choice gamble within an emotion (pleasant, neutral, or unpleasant) either in the gain or loss frame. We found a significant main effect of emotion and interaction between emotion and framing, showing that emotion plays an important role in intertemporal choice depending on the framing of decision context. Our results show lowered discount rates for pleasant and neutral condition in loss frame compared to the gain frame, showing that emotions and framing have opposing effects.We also found lowered discount rates for losses in the largest reward level due to loss amplification property.

Executive function deficits in Developmental dyscalculia: a comparison with Developmental dyslexia and normal controls

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Background of the study: Developmental dyscalculia, is a neuro-developmental disorder that affects an individual's ability to acquire math skills, which cannot be explained by measured intelligence, educational background or visual/hearing impairment. This subtype of learning disability, with a prevalence rate of roughly 6% of school going population worldwide, is diagnosed when significant under-achievement occurs in children with average and above average intelligence, due to underlying cognitive processing problems. As with Developmental dyslexia, both domain- general and domain specific cognitive deficits have been found in children with Developmental dyscalculia. Executive functioning (EF) refers to the cognitive processes required to plan and direct activities, task initiation and follow-through, sustained attention, performance monitoring, inhibition of impulses, and goal directed persistence (Baron, 2004). It is an umbrella term for a variety of higher order cognitive functions, primarily mediated by the pre-frontal lobe, which includes subordinate cognitive functions of working memory, allocation of attention resources, cognitive flexibility, choice of strategies as well as switching to adjust changing demands, concept formation, decision making, self-regulation, judgment, feedback utilization and sequencing of complex actions. Impairments in executive functioning have been reported in children with learning disabilities (Denckla, 1996). Executive function problems have been found to have a close association with mental calculations and arithmetic performance (Mc Lean & Hitch, 1999; Bull & Johnston, 1997; Passonlunghi &Siegel, 2001.) It may even be considered the true link between attention problems and arithmetic difficulties.
Objective: To find out the differences among children with Developmental dyscalculia, other Learning Disabilities and the normal controls, in measures of executive functioning.
Method:
This is a case-control-comparison study. The participants comprised of 61 newly diagnosed cases of Learning disabilities of the age range of 7 to 12 years , who were divided into the Study and the Comparison groups based on the presence or absence of the diagnosis of Developmental dyscalculia and their individually matched controls, making a total sample size of 122 subjects. These subjects were assessed on tests measuring Executive functions viz., the Trail Making Tests (TMT-Parts A&B) and the Coloured Progressive Matrices (CPM) test. The data was analyzed using 2 way ANOVA (3 diagnostic groups against gender), followed by multiple comparison test to pinpoint the differences among groups, when compared pair-wise.
Results:
Statistically significant differences between groups were found in the time of completion of TMT, both in Part A and Part B. While in TMT (Part A), a measure of visual search and sequencing ability, the Study group was s significantly inferior only to the Control group, in TMT (Part B) which is a measure of cognitive set -shifting ability the study group was significantly inferior to both the Comparison group and the Control group. Significant difference was observed between sexes with females performing poorer than males. A significant group x sex interaction was also found in TMT (Part-A), wherein both in those with Developmental dyslexia and the Controls while females out -perform males, in visual search and sequencing ability, this trend reverses in the Study group. Significant deficits were also shown by the Study group in the CPM test, which is a measure of non-verbal inductive reasoning, compared to the Comparison group.

Conclusions: These findings suggest that children with Developmental dyscalculia along with verbal learning disabilities have a specific deficit in set-shifting ability, compared to those with Developmental dyslexia as well as Control subjects. However no such difference has been observed among these two groups in visual search and sequencing skills. So also, females with Developmental dyscalculia along with verbal learning disabilities tend to show more deficits in visual search, sequencing and mental flexibility compared to their male counterparts, unlike the general trend of females being superior to males in these skills, among dyslexics and normal Controls. Findings from the present study also suggest that the inductive reasoning

skills of those children with Developmental dyscalculia along with verbal learning disabilities are inferior to those with Developmental dyslexia. Together these results highlight the fact that, both in assessment and remedial training of children with Developmental dyscalculia, executive functions should be given importance. Future studies could focus on detailed assessments of the various sub- components of executive functioning, among children with Developmental dyscalculia.

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Application of Eye Movement Saccades to Build a Brain Computer Interface

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Patients with disabilities such as locked-in, motor neuron diseases have a limitation to use common communication devices like keyboard, mouse, joy stick, mobile touch screen etc. Brain Computer Interface (BCI), an innovative frontier of science and technology is a direct communication system that responds to the thoughts of users suffering with such adverse ailments and gives feedback to the users by converting their 'command' into an input control for a device. Eye tracking provides a more convenient environment for studying selection or classification-based strategies for BCI development. There are several existing research investigations considering eye blinks as selection command or input modality in BCI. However, such systems usually seem to be less accurate and slow compared to other modalities. It is also tedious to account for involuntary eye blinks in eye tracking experiments. Hence, in this paper, we present a simple, effective tool based on the usage of eye movement saccades for typing keys on a virtual keyboard.

The assumptions made are: the response time required to select a key (keyboard/keypad) manually with fingers is higher compared to selecting it using eye movement saccades. The user's intent to select a key using motor activity depends on a priori visual information related to the position of target key in the setup.

The experimental setup for data acquisition using eye tracking is designed using SR Experiment Builder while the recording data is acquired using EyeLink-1000 and is further analysed using Data Viewer. On the other hand, the same experimental setup is designed using Psych Toolbox where the data is acquired without using eye tracker and is analysed using MATLAB. A total of 6 blocks, each containing 10 trials pertaining to key selection is used as the stimulus. We chose a virtual model of numerical keyboard of a standard keyboard excluding the key-5 whose position is used for the fixation cross in our setup. Three normal users participated in this experiment who gave a prior consent of participation. The trials are designed in such a way that the user is directed to the next trial only on fixating at the centre cue of the screen followed by the stimulus in which the focus of the user rests on the interest area pertaining to the highlighted key for at least 1500ms.

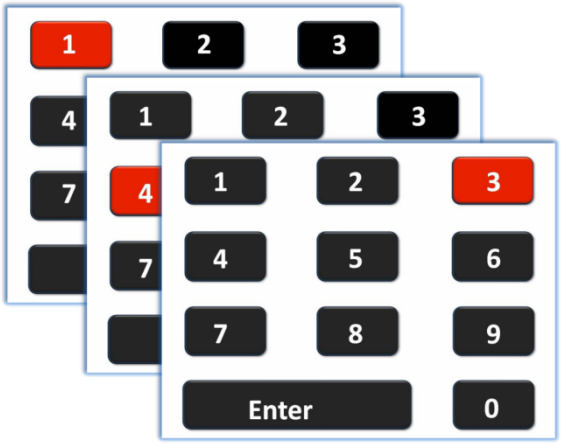

Figure-1: Frame-wise representation of the trials in the experimental design

The validation of the eye tracker's recording data is done using the user's eye movement video trial frames and the key response of the users for randomized and sequential trial blocks and the eye movements and key responses show consistent results. To account for our assumptions and differences in response times across trials of all the blocks and users, we averaged the amount of time spent on each key for all the respective trials. This gaze duration measure represents the proportion of time a user spends on a particular highlighted key relative to all the other keys within a trial.

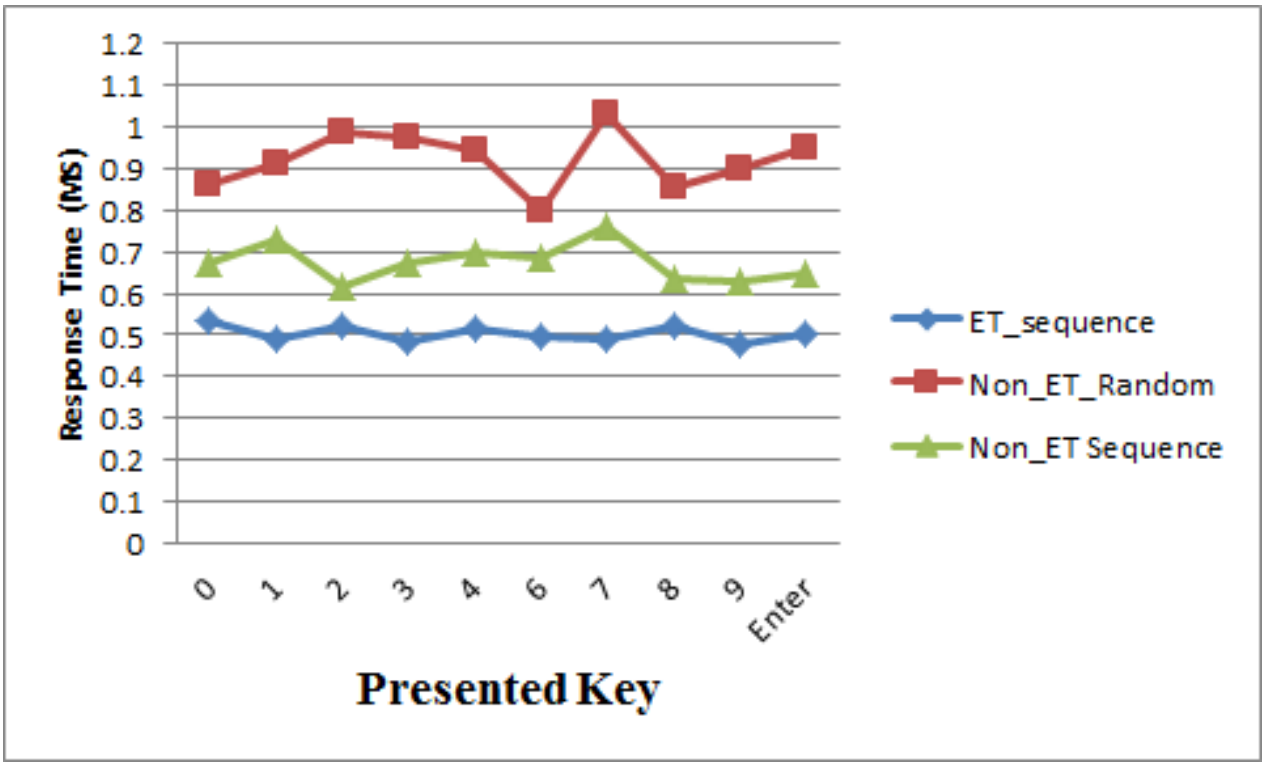

Figure-1: Graph showing the averaged reaction time plots across users for all trials of each key

The graph plotted for the averaged reaction time across trials of each key and users shows a significant variation under the assumed conditions,

Where, Response time represents the time required by a user to respond to the stimulus displayed. ET_sequence represents the data collected using eye tracker when the keys 0-9 were presented sequentially across each block, Whereas, Non_ET sequence represents the occurrence of highlighted keys from 0-9 in a sequential manner in visuo-motor domain.

Non_ET_random represents the occurrence of highlighted keys from 0-9 which are randomized across the trials.

The above results show that the users are faster in performing the virtual key press by their saccades as compared to the manual responses. This allows us to think that saccadic signals as a potential mode of input to register response for people with hand disabilities or hemiplegic patients where people of this category are unable to use their hand for the basic life function. Especially these days, cell smart phones, tablet and computers are a common mode of communication. The use of saccadic response to select keys for dialling a number or typing emails would enable us to use it as a new mode of input. With this revolutionary and essential change, we can include people suffering from specific disabilities to the main stream and provide them with equal opportunities to interact with their environment effectively.

This could further be extended and used to create a setup to visually access all the keys of a virtual keyboard and control an environment of augmented reality.

Finally, it is not about convenience but for severely disabled people, development of such an interface could be the most important breakthrough representing a revolutionary and a technological improvement in the quality of life.

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Attentional Consequences of the Automatic Monitoring of Visual Outcomes of Actions

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It has been suggested that action outcomes are automatically monitored and processed preferentially as compared to other external events. Most of the studies examining the nature of an action outcome use stimuli in the auditory modality for a number of methodological reasons. Theoretically, nevertheless, one should be able to observe similar effects in other modalities as well. In the visual modality, the concept of attention capture concerns itself with automatic processing of particular features or events even when these are irrelevant for the on-going task. Usually, such preferential processing is studied in the context of varied bottom up salience and its relations to top-down task relevant goals. However, if there is an automatic monitoring of an action outcome in the visual domain, it might show up as attention capture even when there are no changes to either the bottom-up salience of a display or the top-down task relevant goals. In the present study we aim to investigate how action outcomes in the visual domain are processed automatically. We used a visual search task employing an irrelevant singleton paradigm that is usually used to examine attention capture by a feature singleton. Figure-8 placeholders (6 or 12) changed to digits either automatically after a beep (No-action condition) or after the participant pressed a key in response to a beep (Action condition). Along with the presentation of the search display, one of the items started moving. The moving item was also the target in 1/9th of all the trials (1/6th and 1/12th of the trials respectively in 6 and 12 display size). The results showed that the feature singleton captured attention in the Action, but not in the no-action condition. The present findings suggest that attention capture by a feature singleton could be mediated by action. That is when an event or feature is perceived as an outcome of action, it binds with action and perceived earlier resulting in attention capture.

Evolution of Chunking Patterns

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In a sequential learning task such as the serial reaction time (SRT) paradigm, it is known that a number of elementary movements are chunked together for efficient motor performance. This is typically characterized by a relatively longer pause before an element of a sequence. Subsequently elements are performed relatively faster requiring only movement times. Here we use a brief learning episode of a 12 element long SRT task to track the emergence of chunking patterns on a trial by trial basis. We define correlation between reaction times of individual elements as a measure of agreement between chunking patterns. We manipulate the sequence four ways. The initial sequence performed by the dominant right hand is mirrored after 5 learning trials. The same sequence and the mirrored sequence are also learnt subsequently using the non-dominant hand. We find a dip in the number of significant correlations amongst our 23 participants, whenever there was a switch in the sequence. Interestingly, even with a brief learning, we observe that the chunking pattern of dominant hand mirrored sequence had relatively more number of significant correlations with the non-dominant hand regular sequence. We also observe that the correlations become stronger towards the end of the experiment (20 trials in all). This suggests that the motor programs characterized by chunking patterns require some time to develop, but the evolution of chunking begins during early learning.

The Malady of Interpreters a Cognitive Remedy

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Polysemy is an important element of research in semantics, its counterpart in pragmatics and communicative discourse being ambiguity. Polysemy and ambiguity appear to be rather uncommon in everyday discourse; but feature frequently in the highly formalised theories of semantics/ pragmatics that we encounter. Words have multiple meanings and can be deployed in communicative situations to serve different functions. But what is evident is that we don't witness disruption or communicative breakdown as frequently in discursive exchanges, as this research warrants. We argue that the projection of language as being made up of highly impoverished data, and as being constantly confounded by polysemy/ambiguity, is an artifact of the semanticist-pragmaticists' analytical methods, rather than a reflection of the 'underdetermined' nature of language.

The key to breaking down the bewildering choice offered by polysemous or ambiguous expressions lies in situating or contextualizing the utterance. How exactly this is achieved by the interlocutors in an exchange is still a somewhat open question. The Pragmatics approach which emphasises the value of the dynamic and contingent 'context' may be seen as an excuse for a highly unbridled relativism (Givon, 2005). The other absolutist extreme is what results in seeing ghosts of underdetermination lurking in every exchange.

Embodied cognition suggests that we use our bodily experience and memory of the world around us to ground newer experiences, in our construal and categorization of linguistic and other information that we gather. The Cognitive (Space) grammar of Langacker(1987, 2008) and the embodied cognition theory of Lakoff & Johnson(1999) and Varela et al (1991) have only gone that far in offering explanatory tools. The same is true of the relevance theorists (Wilson and Sperber, 1986) who describe context as a psychological construct. They offer relevance as an analytical category that sifts the communicative grain from the 'irrelevant' chaff, but are not convincing in saying how one zooms in on the relevant perspective. In this paper, we present some insights that offer a more granular and functional account of how embodied or situated cognition may come into effect during language use and comprehension.

We suggest how embodied cognition has to account for two distinct empirical contiguities – one the individual's own experience of world and the accumulation of all her categories and concepts; the other being the individuals experiences of communicative exchanges with people and her appraisals and evaluations of the communicative context based on prior experiences and intersubjective knowledge. These two domains, we posit, are of seminal importance in situating, cohering and collimating communicative processes.

Further, we suggest the importance of an onomasiological ontology (França, 2009) in classifying and structuring the communicative elements, since this is a truer, more cognitively mapped representation of the semiotic and conceptual elements in speech and writing. This also affords a better enmeshing of the semantic and pragmatic content of linguistic and other forms of communication.

These two major elements will bring analytical strength to the theory of Embodied Cognition (EC), enabling us to add metaphysical depth to our ideas about the relation between language and culture, as demonstrated by the structures of our semiotic categories.

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Development of Affective Control: Evidence Based on the Face-word Stroop Task

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Development of conflict monitoring as a component of affective control across emotional valences such as happy, sad, angry emotions was examined in the present study. Two Experiments were conducted based on the Stroop task with faces with emotional expressions as targets and emotion words (Happy Sad & Anger) as distracters written over the face. Thirty school going adolescents (mean age: 14.7 years) and thirty adults (mean age: 22.6 years) participated in the study. Conflict adaptation was examined in terms of the performance on the current trial as a function of previous trial conflict. In experiment 1 with happy and sad emotional stimuli, results show that conflict adaptation was observed for both positive and negative emotions in both adults and adolescents. Reduction in Stroop effect was observed when the previous trial was incongruent as compared to when it was congruent for both happy and sad faces among adults as well as adolescents. Reduction in Stroop effect was found to be greater for sad faces as a function of previous trial incongruence among adults whereas adolescents showed no difference in adaptation effects between the two emotions. Further analysis suggested that in both the age groups, conflict resolution is faster in the current trial when preceded by a trial with sad facial expression across all conditions (with respect to congruence). Experiment 2 with happy and angry emotional stimuli showed a reduction in Stroop effect when the previous trial was incongruent as compared to when it was congruent for angry faces among adults. Happy faces showed a significant adaptation effect only on low conflict trials when the previous trial was congruent. However, in case of adolescents greater reduction in Stroop effect was observed for angry faces in the absence of a significant adaptation effect for happy faces. Reduction in Stroop effect as a function of previous trial congruence was found to be more for adults indicating better conflict adaptation among adults, however this effect was not found to be significant between emotions. These results suggest that negative emotions (sad and angry) seem to be associated with proactive control mechanisms resulting in faster conflict resolution and better conflict adaptation among adults. However, adolescents show better conflict adaptation only for angry facial expressions as compared to happy and sad facial expressions which could be due to narrowing of attention for negative emotions with high arousal and need for the avoidance of angry faces.

Scope of Attention Modulates Loss-aversion: A Behavioural Economic Investigation

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Attention plays an important role and interacts with various cognitive processes. Selective attention enables allocating resources to a subset of information available for decision making. The amount of information obtained via sampling as well as resources allocated to processing influence the preferred choice. Selection can also influence the weighting of attributes associated with choices available for consideration. The amount of information selected is dependent on the scope of attention. Manipulating scope of attention using global or local processing results in better memory and increased preference for choices made in a complex decision making situation. This indicates that the value for particular choices could be influenced by scope of attention. Hence, we investigated how the changes in scope of attention (focused or distributed) influence economic decision making using the value function of prospect theory. The value function of prospect theory incorporates basic and higher order cognitive parameters related to decision making such as risk and loss-aversion parameters which govern the curvature and steepness of value function, respectively. To address the effect of scope of attention on the value function, we performed two experiments that differed in terms of the scope was manipulated and studied their effects on the risk and loss-aversion parameters. The scope of attention was manipulated either as within-subject letter identification task (Experiment 1: N=27) or within-subject counting task (Experiment 2: N=10) using global or local processing with hierarchical letter stimuli (a big letter made of small letters). The independent variables for the decision making task was loss or gain values associated with a prospect presented in the form of 50-50 gamble and the dependent variable was the choice of either accepting the 50-50 gamble or rejecting to gamble while staying at the status-quo or current wealth. In Experiment 1, each trial consisted of a global-local letter followed by the gamble. Participants identified the global letter in one block and local letter in another block. Participants indicated their choice followed by identification of the global or local letter. In Experiment 2, participants performed a counting task for a letter at either the global level or at the local level. The participants had to undergo the attention task followed by the decision making task similar to the experiment 1. In both the experiments, we hypothesized that local processing will increase the tendency of loss aversion and risk aversion behavior. Based on the dependent variable data and computational procedures adopted for prospect theory, we computed alpha (curvature of value function reflecting risk parameter) and lambda (steepness of value function over losses reflecting loss aversion). The results from both the experiments consistently indicated negative skewness of loss aversion values for local attention and positive skewness of loss aversion values for global attention across the participants. However, the risk parameter distributions varied in their behaviour and this needs to be investigated in future with larger sample sizes. The results from these studies indicate that the value is influenced by scope of attention and the robust form of prospect theory need to consider attention related mechanisms.

ROLES OF EXPRESSIONS IN CONSTRUING MEANING AT THE LEVEL OF DISCOURSE: A STUDY OF NOMINALS AND DEMONSTRATIVES IN BENGALI

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Abstract

Constructing meaning at the level of discourse always involves incorporation of large amount of information. The present work will show (i) the role of linguistic expressions in controlling the inflow of information in discourse interpretation and will also explore (ii) the role of the linguistic expressions in licensing valid inferences while interpreting a discourse. In doing so, the paper will conceptualize a linguistic expression as a repository of default structural information. This default structural information in conjunction with the background knowledge of the interpreter is crucial in figuring the intended sense of a communiqué.

While exploring the issues of meaning construction at the level of discourse, this work will compare the meaning construing capacities of nominals and demonstratives in Bengali. What motivates me in comparing these two types of expressions' meaning construing capacities is as follows: Unlike nominals, demonstratives possess no contents. As a consequence, the role of demonstratives in the construction of meaning remains purely context sensitive; whereas the meaning construing capacities of the nominals are a complex interplay of context and the content. It is being argued by Ghosh [1], discourse level processing should have some sort of model-theoretic explanation for how in a context a particular nominal is connected with its other senses, since the meaning construing potentiality is determined strictly by the context. Sometime these connections are explicitly stated (as is the case with demonstratives), and sometime connections are inferred if the expressions are contentive (as is the case with nominals). In my approach, I will try to augment a model of language processing at the level of discourse, proposed by Karmakar and Kasturirangan [2,3,4,5], to maximize the scope of the model.

The proposed model conceives a linguistic expression as a mental regulation consisting of intending function (= $\mathbf{I_f}$) and contending function (= $\mathbf{C_f}$). $\mathbf{I_f}$ is useful in activating default contextual information associated with a particular linguistic expression; whereas $\mathbf{C_f}$ is unique in coercing the default contextual information for establishing connections across the discourse. These two functions, I will show, play a crucial role not only in construing meaning at the level of discourse but also in determining coherence and logical stability of a linguistic discourse.

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Anxiety and Temporal Discounting: A Behavioural Economic Approach

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Decision making is the process of choosing the best possible valued outcome among alternatives available and the expected outcome of decisions could be either positive or negative valance value. The expected outcome is often represented as the multiplication of probability and value or time and value of an outcome. The expected outcome with time and value involve temporal discounting and literature show that they people follow different types of temporal discounting functions or profiles with the parameter reflecting the type of individual. It was also observed that the impulsive people often have steeper discounting rates than non-impulsive individuals. The experimental designs investigating temporal discounting often involve participants to choose between small immediate reward (SIR) and large delayed reward (LDR). However, personality traits can also interact with the process of decision making and recent interest in behavioural economics has been to incorporate this personality related variables in the economic theories. The anxiety is one of such variable and it is as an adaptive emotion, aimed at directing an individual's responses towards threatening stimuli in order to cope with possible dangers. The aim of this study was to characterize the discounting rates in high and low anxious individuals in positive and negative frames at different levels of LDR. Earlier studies found that the anxiety in general was associated with increased avoidance of risky decisions, pessimistic risk appraisals and the risk-aversive individuals were shown to have faster discounting rates than less-risk averse or risk-seekers. Based on this earlier research, we hypothesized that the high anxious individualswould have higher discount rates than low anxious individuals. To test this hypothesis, we used intertemporal choice task with positive valance outcomes and was adapted for Indian population. The study was conducted on 16 participants (8 in high anxiety and 8 in low anxiety group) from University of Allahabad (mean age = 21.0 years) and the state anxiety scores were obtained from Spielberg anxiety inventory in the Indian context.

The results revealed that the high anxious individuals in gain frame alone showed higher discounting rates (i.e. large discounting parameter value) for small and large levels of LDR compared to low anxious individuals. Further, it was also observed that the higher discounting rate was found in gain frame compared to loss frame for large level of LDR in high anxious group alone. In contrast, we observed higher discounting rate in loss frame compared to gain frame for small level of LDR in low anxious group. Future studies are needed with larger sample in each group and the current study revealed differential roles of anxiety on framing and levels of delayed outcomes in temporal discounting tasks.

Semantic and Syntactic Language Processing in Temporal Lobe Epilepsy (TLE) Revealed by fMRI

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Purpose: Language functioning may be affected in patients with chronic intractable epilepsy especially in left hemisphere. BOLD contrast based functional MRI was used to map the cortical language network in patients of chronic intractable epilepsy prior to and after six months of surgery.
Method: After obtaining the institute ethics approval, 13 consecutive patients with intractable epilepsy and 15 controls (Table 1) were recruited in the study. Thirteen patients underwent anterior temporal lobe resection (ATLR). FMRI was performed using single-shot echo planar imaging (EPI) sequence on 1.5T MR scanner (Avanto, Siemens, Germany) with 12-channel head coil.
Design of the study involved meaningful word reading task, semantic judgment task, syntax reading task, comprehension syntactic-semantic task presented for a duration of (503 S) using visual cues with MR compatible audio visual stimulus system with binocular LCD goggles (Nordic Neuro Lab, Norway) during the active phase. The responses corresponding to semantic judgment task were recorded using 4-key button pad (Lumina LP 400, Cedrus Inc, USA). Data analysis and group comparisons were carried out using SPM8.
Results: Preoperative data revealed less neural activity in inferior frontal gyrus and superior temporal gyrus in patients. Strong BOLD activation was observed post surgery in left Inferior frontal gyrus, middle frontal gyrus and superior temporal gyrus during lexical reading and semantic reading task in comparison to judgment and comprehension syntactic-semantic task (Figure 1).
Discussion: Disturbances in language network revealed by BOLD in intractable epilepsy patients may be due to intractable seizure discharges and pathological abnormality. After surgery, specific language components (lexical, semantic, syntactic processing) were restored in TLE patients. However BOLD activation in MTG and STG involved in integration of semantic and syntactic information and is particularly responsive to meaningful sentences during semantic reading task [1,2]. Patients who were affected by hippocample sclerosis showed atypical language lateralization suggesting the role of hippocampus involvement in semantic and lexical information, and can raise questions regarding the specific roles of medial and lateral temporal cortex in targeted word retrieval [2].
Conclusion: Atypical language lateralization is observed in intractable epilepsy patients, especially in left hippocample sclerosis.

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Is Sentence Comprehension in Adult Bilinguals a Conscious Switching?

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Introduction: The language processing in bilinguals share same cortical areas for first (L1) and second language (L2) where L2 recruits greater activity from same regions [1] like left inferior frontal cortex [2]. Difference in bilinguals and monolinguals processing is that in bilinguals left middle temporal gyrus [3] and caudate [4] play role in conscious switching, monitoring and controlling the language used. In India Hindi as L1 that is phonetically transparent with subject object verb (SOV) word order and English as primary L2 that is phonetically partially opaque with SVO word order, whether influence the neural processing was targeted in the present study.

Methodology: After IEC approval pilot study was conducted on eight healthy multilingual subjects (age range 25 to 45 years) with standard inclusion criteria of right handedness, bilingual with proficiency in L1 and L2, given written consent and exclusion criteria any sensory impairment (hearing/ vision), neurological or psychiatric problems, any contraindication for MRI. Single-shot echo planar imaging (EPI) sequence on 3T whole body MR scanner (32 channel head coil) (Achieva 3.0T TX, Philips, Netherlands) was used for Blood oxygen level dependent (BOLD) data (slice thickness =5 mm, number of slices = 29, TR: 2000 ms, TE: 30 ms, flip angle = 90□, FOV = 230 mm, Dynamics: 360, Resolution: 64x64), overlaid on anatomical images using conventional T1-weighted 3D sequence. The visual text stimuli were presented using Eprime (version 1.1, Psychology Software Tools Inc, USA) and MR compatible LCD monitor (NordicNeuroLab, Norway). The two tasks comprised of 30 (15x2) syntactic events (in Hindi and English languages) where each event was of 10 s duration. The paradigm included block of simple sentences of 3-4 words (6-9 syllables) in either language selected randomly and the response was oral reading. Duration of the fMRI data acquisition was 9 min 50 s (590 s). Pre- and post-processing was done using SPM8 (Wellcome Department of Cognitive Neurology, London, UK). The group data was analyzed by one-way ANOVA test ($p<0.001$, cluster threshold 5).

Results and Discussion: In all the subjects the performance was similar in both L1 and L2 for auditory comprehension. In six subjects better speed and proficiency was observed for L2 reading performance. The BOLD data showed that L2 recruited left hemispheric dominance of lingual gyrus, caudate and right dominance of middle temporal gyrus, middle occipital, fusiform gyrus (Table1) [1-4]. On comparison of English vs. Hindi significant BOLD activity was observed in left inferior frontal gyrus [3] and right lentiform nucleus (Table2).

Conclusion: The results indicate that in bilinguals there is conscious switching of language but not affecting the proficiency and reaction time. The study evidence the role of left caudate in second language use.

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Combining Gated Dipole with Reinforcement Learning Framework for Unitary Account of Reward-and-punishment Based Learning

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Learning is an everyday phenomenon. Researchers in possibly every domain of science have been fascinated by this phenomenon as it forms the basis of understanding human and animal behavior. Tracing the history of development of different theories in this domain, additional weightage is given to the work done by Skinner. His theory, known as “Operant Conditioning”, suggested that the organism needs to operate on the environment, leading to a response, which then leads to a Reward or Punishment. If the response leads to a rewarding condition, the probability of the response occurring again increases; thus, organism “learns” to repeat the response to that stimulus, i.e., Appetitive conditioning. Similarly, if unfavorable events follow the response, the organism is “punished” and thus learns to not repeat the response to that stimulus. i.e., Aversive conditioning.

Reinforcement Learning (RL, Sutton & Barto, 1998) has been proposed as a theoretical framework (REF, Grossberg 1972) to account for nuances in learning by either reward or punishment. In this paper we will review the differences in brain areas subserving both types of learning. The role of Dopamine and Serotonin will be highlighted as these neurotransmitters play a significant role in learning behaviour., We suggest that the computational framework of gated dipole (REF) could be utilized to account for the possible opponence played out by these two neurotransmitters in appetitive and aversive conditioning. An attempt to juxtapose the concepts of learning on this gated dipole mechanism will also be made.

Are an ability to shift attention and creative cognition related?

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Abstract

Objective

The current study aims to investigate the relationship between an ability to shift attention from one target/ task to another and creative cognition. We assume that performance on both tasks, although evolving in different time scales, might be based on a general cognitive flexibility. Two experiments were conducted (N_1=50, with SPM; N_2=50, with APM) by employing attentional blink (AB),working memory operation span (WM OSPAN), Raven's progressive matrices (RPM), creative reasoning task (CRT), and test for creative thinking and drawing production (TCT-DP).

Methodology

Participants:

Total hundred and five volunteered (63 male and 42 female, between 18-30 years) participated in both the study for pay. The participants were recruited from either by the advertised email send to Kaiserslautern University students' email-id, by contacting them by phone call from the list of participants showed interest to participate in future experiments. All participants reported having correct to normal vision. Participants were not familiar with the purpose of the experiment.

Materials:

In attentional blink (AB) or rapid serial visual presentation (RSVP), an array of English letters along with two digits were presented at the centre of the screen. Digits were presented as targets, with varying temporal gap from lag 1 to lag 8. Participants' task was to identify the targets and report at the end of a particular trial. Participants were seated at a viewing distance of about 50 cm from the fixation mark (+).

Standard Progressive Matrices, and Advance Progressive matrices (SPM/APM) consisted of sixty and thirty six incomplete matrices respectively. Each incomplete matrix is displayed together with eight alternative possible answers. Participants' task was to complete the matrix by selecting the correct answer from the multiple alternatives given below. Participants were instructed to give the corresponding responses on a separate sheet given along with APM booklet.

Creative reasoning task (CRT) consisted of an empty 3x3 matrix. Participants' task was to create an APM-like puzzle. Participants were instructed to make a puzzle similar to the puzzles they have solved. The puzzle was expected to have an answer / missing piece as well. Participants were requested to make the puzzle as original and complex as possible.

In working memory operation span (OSPAN) task, participants were presented with mathematical operation – word pairs varying from two to six sets. Participants' task was to read the

operation out loud and press “yes” or “no” to indicate whether the given answer was correct or incorrect and then recall the words in the order of the presentation.

Procedure:

The study consisted of two sessions, including AB, WM OSPAN, SPM/APM, TCT-DP, and CRT. Half the participants performed AB followed by WM or vice versa in first session and APM/SPM followed by CRT and then followed by TCT-DP or vice versa, in second session. In this case, SPM/APM was always followed by CRT, but TCT-DP temporal order was changed across participants. In addition, sessions were also counter balanced across participants. The overall experiment lasted for approximately two hours.

Results and Conclusion

Currently, analysis is in progress. Based on second experiment (consisted of AB, WM OSPAN, CRT, APM and TCT-DP), N=50, results showed no significant correlation ($p>.05$) between AB and creative reasoning, suggesting possibly distinct cognitive mechanisms underlying these two processes. More can be suggested based on further analysis, which is expected to be completed soon.

Affect and time perception

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There is a large body of literature to show the role of emotions in cognitive activity. However, there is a dearth of studies analyzing the relationship between emotional states and estimation of time durations. Furthermore, studies that have been conducted to investigate the relationship between emotions and time perception have typically yielded inconclusive results. One possible reason for these inconsistent findings might be the uses of non standardized emotional manipulations that restrict the quantification and the replication of the results rather problematic. Also these studies have used different type of emotional stimulus where the comparability of these stimuli is a question. Having these gaps in mind the present study was conducted to examine the effect of perceiver's affective state and affective valance of the stimulus on perception of time under retrospective paradigm. A total of 55 participants watched a visual clip depicting a crime scene affectivity of which was manipulated by providing additional details about the scene. Participants' task was to reproduce the time duration for the stimulus. The findings of the initial statistical analyses suggest that the estimation of the time duration was significantly influenced by the affective state of the perceiver and perceived affective valence of the clip. The detailed results are discussed in light of the existing theories of time perception and are expected to add interesting findings to the current literature.

On the road to being a simultaneous biliterate: cortical circuits in children learning to read two distinct writing systems

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Abstract: The emergence of bilingual societies has given rise to educational milieu wherein children are required to be biliterate, namely acquire reading skills in distinct writing systems. To investigate how biliteracy shapes developing cortical reading networks, we performed functional imaging on 34 simultaneous Hindi-English biliterate children matched on reading ability across languages, as they read word and nonword stimuli. Hindi, an alphasyllabary and English - an alphabetic system, differ in consistency of sound-to-letter mapping or orthographic depth. Consequently, the inconsistent orthography of English necessitates discrete reading strategies – lexical retrieval and phonological assembly, unlike Hindi which being transparent, relies only on assembled phonology. Simultaneous biliterate children recruited a shared reading network comprising bilateral hippocampi, precentral and postcentral gyri (BA 3/4), middle and inferior occipital gyri (BA 18/19) and cerebellum, which we attribute to similarity in phonological units across both languages. Factorial analysis showed that stimulus type (word/nonword) modulated activity in bilateral inferior frontal opercula (BA 44/48), superior parietal (BA 7) and left inferior parietal lobules (BA 40), and angular gyrus (BA 39). Orthographic differences were revealed by subsequent comparisons which showed differential activation patterns for words and nonwords in English but not in Hindi. Our findings also revealed an important role for hippocampus for non-native language reading in children. We provide novel evidence for the role of orthographic depth in shaping cortical reading processes early in development. Our results

demonstrate that developing biliterate reading networks not only exploit similarities in phonological representation but are also sensitive to differences in orthographic depth.

Keywords: bilingualism; development; fMRI; language; reading acquisition.

Abstract

Hand proximity attenuates attention capture by a feature singleton

Tony Thomas and Meera M. Sunny

Many recent studies have shown that objects nearer to ones limbs are processed differently relative to objects farther away. While some studies have shown preferential processing of targets, others have shown a performance cost in detecting targets presented nearer the hands as compared to without hands. That is, there seems to be two different effects that play out in hand proximity, one where there is a priority for objects near the hand, and others in which disengagement becomes slower for objects near the hand. However, there is no conclusive evidence for this hypothesis and it seems that there is a contradiction in the literature with both a benefit and a cost associated with objects in the peri-hand space. The first two experiments were conducted to check whether the hand-proximity effect is replicable and if so, to see whether it survives in the presence of a countering effect in terms of bottom-up salience. In Exp.1, participants performed a standard letter search task in two different display sizes (6 and 12). During the search, they either placed an index finger on each of the four corners of the monitor ('with hand') for a fixed number of trials or rested the hand on their lap ('without hand'). In the 'with hand' condition, the target appeared either within 876 pixels from the index finger (near condition) or more than 876 pixels from the index finger (far condition). Relative to the without hand condition, a steeper RT slope was found in the 'with hand' condition indicating a relatively inefficient search. Prima facie, this conforms to the earlier findings of a cost associated with hand proximity and hence supports slower attentional disengagement near the hands. In addition, better performance in near than far condition also fits with findings suggesting an increased prioritization of targets falling in the area near the hand. The second study was done to see whether this prioritization would persist even when there is a task irrelevant singleton distractor present in the search display. In Exp.2, every trial had one of the letters presented in red colour, and could coincide with the target in $1/9^{th}$ ($1/6^{th}$ and $1/12^{th}$ for display size 6 and 12 respectively) of all the trials. In spite of the presence of the singleton, the results showed that targets presented nearer to the hand was responded to faster than to those targets presented farther away, suggesting that the hand-proximity effect over-rides bottom-up salience effects. Moreover, we found a stronger capture for the without hand condition as compared to the with hand conditions suggesting that the proximity of the hand to the target attenuates capture by a feature singleton. We also found that there is some capture in the far condition as compared to the near condition. Overall, the results provide further empirical support for the hand-proximity effect and also suggest that it interferes with a bottom-up or salience based allocation of attention.

Is Implicit Sequence Learning impaired in Deaf Children with Cochlear Implants?

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Introduction

Deafness, a lack of sense of hearing may exist from birth, unless identified in early stages and intervened appropriately, a period of auditory deprivation can result in cortical reorganization and subsequent deficiencies in sequencing abilities and language development (Sharma & Dorman, 2006), specifically, because auditory stimulus by its very nature is a sequential signal extended over time. Indeed, previous work suggests that the profoundly deaf showed some disturbances in (non auditory) functions related to time, such as serial order, and immediate serial recall (Horn, Davidson, Pisoni, & Miyamoto, 2005; Marschark, 2006). A cochlear implant (CI), is an electronic device that directly stimulates the auditory nerve to create the percept of hearing. It provides the means to successfully develop spoken language skills.

Visual implicit sequence learning experiments on deaf children (Cochlear implanted), conducted by Conway et al (2010) using Artificial Grammar Learning (AGL) paradigm, showed that normal-hearing children's sequence learning was significantly better than that of deaf children, who on average showed no learning. Furthermore, deaf children were not impaired on several other non- sequencing tasks; such as visual-spatial memory and tactile perception.

Serial Reaction Time (SRT) paradigm developed by Nissen and Bullemer (1987), is considered better than the AGL paradigm to measure implicit learning for several reasons (Destrebecqz & Cleeremans, 2001). The probabilistic version of SRT task is particularly appropriate and is more ecologically valid (Jiménez & Vázquez, 2005). In the SRT task, subjects typically watch one of four dots light up in a predetermined order and respond by pressing the corresponding button. Learning results in faster and more accurate performance on these patterned blocks as compared with a block of random trails. Hence, it is felt that

there is a need to know whether implicit learning is affected in deaf children with CI, when measured using SRT task.

Method

Subjects

Three groups of children , each group consisting of 25 children aged 8-12 years with deafness, were included in the study; those that are fitted with cochlear implants; those fitted with hearing aids and children with normal hearing as a control group. These children have normal vision with the following inclusion criteria.

- Hearing Impairment: Bilateral Severe to Profound congenital hearing loss (> 70dB)
- No known neurological and psychological problems, cognitive and motor problems

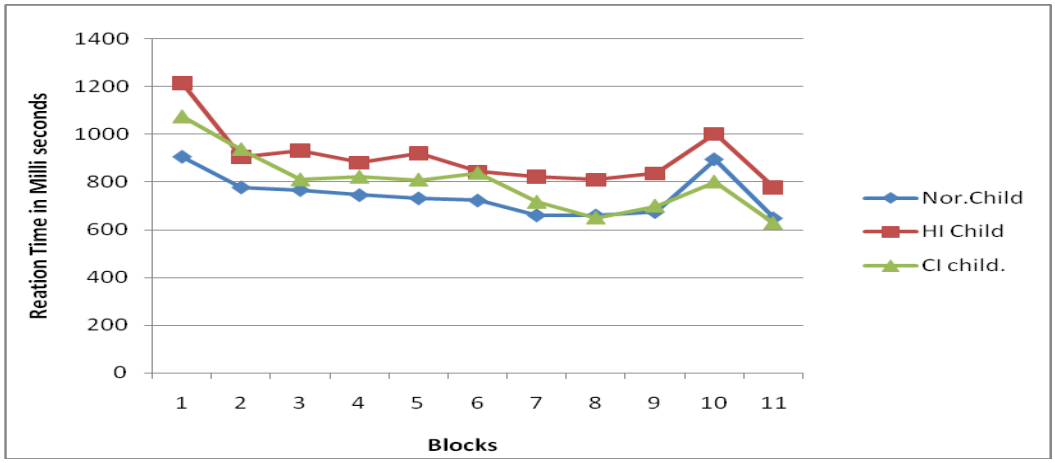
Equipment and Procedure

SRT task was designed using Matlab and Cogent software. 1/3 inch circle (black color) is presented in a sequence of locations generated from a second – order markov process (ex. 1-2-1-3-4-2-3-1-4-3-2-4) inside one of the four 1- inch square boxes, aligned horizontally, and separated by 2cm gap (against white color back ground) on the screen using Dell laptop computer. The children were instructed to press the corresponding key, as fast as possible, when the circle is present in the box. Subjects had to respond with their left and right index and middle fingers that were placed on the keys 'Z', 'X', 'N', and 'M'. The reaction time (RT) is recorded for each response. The next trial is presented after 250ms after the response. 11 blocks of 100 trials each were presented. In blocks 1-9 and 11 the stimuli followed a repeated probabilistic sequence of 10 elements. In the10^{th} block stimuli were presented in a random sequence. Explicit knowledge about the sequence is tested using interview method, by taking written responses.

Mean response times (RT) for each of the 11 blocks for all the 3 groups is calculated. The difference in RT in the random block 10 and the preceding and the following structured blocks 9 and 11 were taken as an index of sequence learning and also in blocks 1through 10.

Results, Discussion & Conclusions:

Fig.1: Block wise mean reaction time for different populations



Blockwise reaction times from 1-11 clearly demonstrated a learning effect as expected in a standard SRT paradigm, in all the three groups of children i.e. children with normal hearing (Normal), children with deafness fitted with cochlear implants (CI) and hearing aids (HI). The mean values of reaction times (RT) for blocks 9, 10, and 11 for the 3 groups are shown in table-1.

Table-1: SRT results of the three groups

Group	Mean of Reaction Time in ms			
	Block 1	Block 9	Block 10	Block 11
Children with Normal Hearing	906.06	674.83	895.45	648.43
Deaf Children with CI	1076.03	700.26	801.11	627.77
Deaf Children with Hearing Aid	1213.26	836.16	1000.97	777.18

Further to know the statistical significance of learning effect, repeated measures ANOVA was performed with “group” as a between-subjects factor and “blocks” as a within-subjects factor., ANOVA showed an insignificant effect for the group [$F(2, 61) = 2.245$, $P>0.05$] but showed a significant effect for the factor blocks on response time [$F(10,52) = 11.825$, $P<0.05$]. Lack of a significant Interaction between group and block [$F(20, 106) = 0.914$, $P>0.05$] suggests that improved RTs due to practice did not vary with the type of rehabilitation device.

The result of this study demonstrate that visual sequencing skills are not impaired in deaf children fitted with cochlear implants, which is in contrast with the finding of the study

conducted by Conway et al (2010). The deviation may possibly be due to procedural variations, as it was said that the SRT task is a better paradigm to measure the sequence learning than AGL??, since it is more ecologically valid (Destrebecqz & Cleeremans, 2001). Better reaction time performance in deaf children with cochlear implants compared to those with hearing aids might be due to the restoration of hearing and auditory experience post implantation. Further studies have to be carried out on a larger scale to explore disturbances in sequence learning skills in deaf children fitted with various rehabilitation devices.

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Bilingual Language Processing

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A bilingual is a person who has developed competencies in the two languages. He or she may be using the two languages in different domains of life and in different contexts, depending on the need and uses of the two languages. Thus, bilingual is rarely equally or completely conversant in the two languages. Over the past few years there has been an enormous effort to explore the way in which more than one language is represented and processed. Behavioural techniques have yielded considerable progress but current data leave a number of questions unresolved. The paper attempts to highlight some of the major interpretative issues related to bilingual language processing. The present research was carried out on Hindi-English young adult bilinguals with a purpose to examine how they would perform on various Hindi and English tasks such as picture naming, verbal fluency, reading fluency, comprehension and translation. The findings revealed that the balanced bilinguals performed more or less the same on Hindi and English tasks. Hindi dominant bilinguals performed significantly better than English dominant bilinguals on Hindi tasks while English dominant bilinguals performed significantly better than Hindi dominant bilinguals on English tasks. For balanced bilinguals, expressing and comprehending a communicative intention may be an inherently competitive process. They may be trying to manage competing phonological, syntactic and prosodic systems and distinct mappings of orthography to phonology. Questions are being raised regarding the processing efficiency of a bilingual person. Strong evidence is available from neuroimaging studies which claim that (1)there is common neural network subserving L1 and L2, (2) there is competition to control output in L2 vs L1, and (3)inhibition is a key mechanism in language control and lexical selection. Research evidence indicates that increase in proficiency is accompanied by a shift from controlled to automatic processing and this will be accompanied by a reduction in prefrontal activity. Thus in order to interpret behavioural and neuroimaging data correctly, we need to take proficiency into account. The paper highlights the need to examine tasks specific to bilingualism, for example, language switching in picture naming and translation with a view to identifying the role of the various control structures. By and large the research studies have indicated that lifelong experience in managing attention to two languages reorganizes specific brain networks, creating a more effective basis for executive control and sustaining better cognitive performance throughout the lifespan.

Affective Influences on Prospective Memory

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Prospective memory, referred as remembering to do something in the future, is a distinct form of memory that encompasses the formation, retention, and future retrieval of intended actions that are encoded for future purposes. It has been divided into two task categories namely habitual tasks or routine tasks and episodic tasks or non-routine and less frequent tasks. Similar to other forms of memory, prospective memory has also been shown to be affected by emotional state of the person and/or of the task. Studies have found that the emotional valence of an intended action seems to exhibit effects on the likelihood that the task is remembered and carried out. However, for uncomfortable intentions there might be a relatively high probability of that they remain unperformed. Studies have interpreted better performance of highly anxious participants as an evidence that anxiety leads people to monitor the environment and the passage of time more frequently, which results in better prospective memory performance. Studies also provide evidences that negative emotional states might interfere with the accurate remembering to carry out future intentions, but not with the accurate remembering of past information.

Forty-eight undergraduate students of both the genders falling in the age group of 18 years to 25 years were asked to give their daily agenda of work they had decided for the day, like things that they need to buy from the shop or any mails that they need to receive. They were also administered questions to assess their mood states like how they were feeling or whether they had a good sleep last night. At the end of the day a follow up report was taken from all the participants of the intended tasks remembered and accomplished. The results demonstrate that prospective memory is enhanced when participants are in a positive emotional state and that this effect is related to better performance of intended actions. The results also demonstrated that the nature of the task also have significant effect on its prospective remembering. The detailed results presented in full paper are expected to explain the existing theories and researches in this area and proposes some to the unanswered research questions open for future investigations.

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A NOVEL "EMOTIONAL ODDBALL PARADIGM": TO STUDY THE INFLUENCE OF EMOTIONS ON TIME PERCEPTION

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According to Einstein, "When a man sits with a pretty girl for an hour, it seems like a minute. But let him sit on a hot stove for a minute -- then it's longer than any hour. That's relativity". This famous statement suggests that unpleasant events are perceived to be longer than pleasant events, even when both are exposed for the same time duration. Time, as a fundamental cognitive activity is sometimes influenced by our emotional state of mind. Several studies have shown that in an elated state time seems to move faster whereas in a sad or bored state time seems to move at a slower pace or it seems to stand still. It has also been seen that people experiencing a dangerous and/or a traumatizing situation, such as in case of robbery, report that the event seemed to be everlasting compared to those who were bystanders or eyewitnesses. This perceived expansion in time is referred to as Time Subjective Expansion (TSE).

Studies based on emotion and time perception have shown that perceived duration of emotional stimuli seemed to be longer than in the case of neutral stimuli. Arousal based models suggest that emotional stimuli elicit heightened responses than the neutral ones. On the other hand, attention based models suggest that this phenomenon occurs due to allocation of attention which causes violation of time judgement in different emotional states. According to Ohman et al. (2001), negative facial expressions detract attention away from temporal processing more than positive expressions, which in turn is likely to alter our perception of time. Droit-Volet et al. (2007) conducted a series of experiments to study how emotion influences our temporal judgement in which they found that both sad and happy faces with Duchenne smile produced an overestimation of time, while non-Duchenne smile did not.

So far, most studies have employed Temporal bisection task, Emotional regulation paradigm and Attentional-blink paradigm to study the impact of different emotions on perception of time (Droit-Volet et al., 2007; Mella et al., 2011; Anderson et al., 2001). In a Temporal bisection task, the subject needs to report the perceived duration of each stimulus as either long or short. In the Emotional regulation paradigm, the focus of the subject was to be modulated between one of the three, namely: time, emotion or both simultaneously, in accordance with the instructions given by the experimenter. The Attentional- blink paradigm has also been studied for emotional and neutral stimuli, where after the identification of a target stimulus (T1), there is transient impairment in the awareness of a subsequently presented target (T2) and this impairment shows an interaction between T1-T2 temporal lag (early versus late).

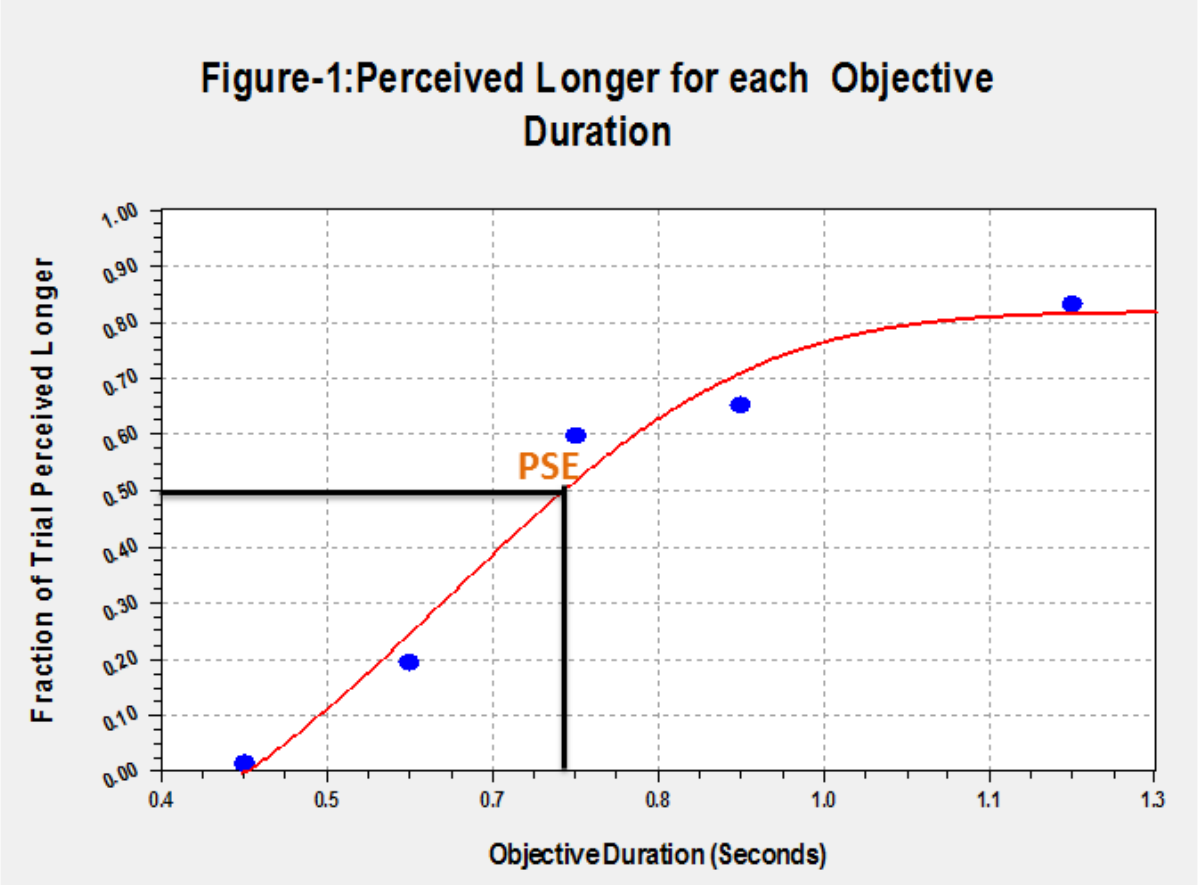
The Oddball paradigm is a well-established method to study time perception, which is used in a wide range of studies with various stimuli and shows the expansion and contraction effect, yet it has not been applied to study emotions. In an Oddball paradigm, the subject is expected to judge the time duration of an oddball stimulus within a train of standard durations.

According to Tse et al. (2004) when an oddball occurs, more information about the stimulus is processed per unit of objective time, leading to TSE and therefore the oddball is perceived longer than the standard durations.

The aim of the present study is to introduce a novel "Emotional Oddball Paradigm" to study the influence of emotion on time subjective expansion (TSE).

Methodology: The stimuli utilized to conduct this experiment were photographs of human faces. Four observers (2 males and 2 females, mean age 23years) were presented an oddball (Happy/Sad face) in a train of standards (Neutral faces). They were asked to respond whether the duration of the oddball stimulus was longer or shorter with respect to the standard. The standard was presented for 1050ms throughout the experiment with a jittered inter stimulus interval (ISI). The 5 objective oddball durations varied from 450, 600, 750, 900 and 1200ms.The design of the oddball experiment follows that of Tse et al. (2004).

Results and Interpretation: The analysis was done in Matlab, where all data was gathered and analysed. The average results of the pilot data on 4 subjects are shown in Figure 1. The Point of Subjective Equality (PSE) is the point at which the observer responded "longer" on half the trials, which was obtained by fitting a Weibull curve at ~738ms. Thus, an oddball lasting ~738ms was judged longer in duration as a standard lasting 1050ms. The TSE was calculated by dividing the standard duration presentation time by the PSE value, which is equal to ~1423ms, showing that the oddball was thought to expand for 1423ms. The subjects identified the emotions with 98% accuracy.



Based on the results we can conclude that an expansion is visible in the presented emotional stimuli and influences our time perception, which is consistent with literature that emotional stimuli (sad/happy faces) produce an overestimation of time. The results of the study also helped to establish a novel "emotional oddball paradigm" where one can have a quantitative measure of subjective time expansion which happens due to emotional stimuli. It helped us to calculate how long the perceived duration of the oddball seems to be and not just whether it was perceived as longer or shorter, but a value to objectify the measure.

The current results add to the growing evidence that perception of time may be fundamentally linked to our subjective experience, in this case, our emotions.

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Interference and attention: What do bilinguals tell us?

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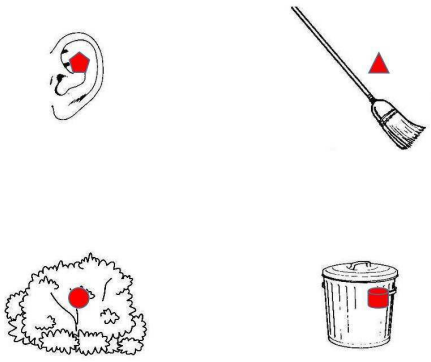
Attending to goal directed stimuli in the face of interference is a remarkable cognitive skill. Unfortunately our goals change because of constant influence from several top-down and bottom-up influences in the environment. In this presentation we present research which shows interference in bilinguals in a visual detection task due to unintentional activation of semantics. Previous studies have shown that bilinguals access cross-linguistic semantic information unconsciously (Singh & Mishra, 2013). However, it is not known how language fluency may modulate this behaviour. Further, little is known about the interference this may cause with another ongoing task. We present findings from two studies where different manipulations of selective attentions have been performed. In one study we observed that highly fluent bilinguals are much slower compared to low proficient bilinguals in a task where they had to detect colour change of an object. We used the visual world eye tracking paradigm for these two studies where participants attend to both spoken and visual stimuli and their eye movements are tracked. The display had a phonological competitor of the translation equivalent apart from distracters. The slowness of highly fluent bilinguals in programming a correct saccade indicates spontaneous activation of translation equivalents from spoken language leading to oculomotor capture by distracters. In another version of the experiment we tested if bilinguals still activated the translation equivalents when selective attention was manipulated. We asked participants to remember digits or geometrical figures superimposed on line drawings in a visual world task. The display of line drawings had the spoken target, a phonological cohort of the translation equivalent and a semantic competitor apart from a distracter. Two groups of participants with high and low L2 proficiency participated in this study. We are still analysing the results of this study which we will present. These studies are theoretically important as they reveal the extent of bilingual executive control in linguistic and non linguistic tasks.

Below is the description of a sample trial of the second experiment.

The trial started with a fixation of duration 1000 ms. The spoken word “broom” was then presented. The transition equivalent of “broom” in L1 is “Jhadu”, a phonological cohort of which is “Jhadi”. The display (shown below) thus contained the line drawings of a broom, a “Jhadi”, a semantic competitor of spoken word “koodadan” and a distracter “kaan”. The onset of spoken word and the display was simultaneous. The display was shown for a duration of 3000 ms after which a question was asked, “Did you see a triangle?” . The subjects were asked to indicate their response through a button press.



(We acknowledge DST for support for this research)

A Cognitive Appraisal of the Psychology of Vagueness Across Languages

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Vagueness is an inalienable feature of ordinary language. Most speakers are confused about the applications of vague predicates like ‘tall’, ‘old’ and ‘red’ to border-line instances. Bonini et al (1999) conducted some psychological experiments to determine which of the following theories best apply to ordinary understanding and use of vague predicates, viz.,

Super-valuations (gap theory)

Sub-valuations (glut theory)

Epistemic theory (lack of knowledge)

Bonini used 1st order logic to devise experiments to find how Italian speakers used vague predicates and he supported Epistemicism. His data, however, showed very different results when replicated with English speakers. There were some errors in Bonini’s studies:

(a) The questions have a presupposition as if there really is a precise boundary between tall / not tall man.

(b) Conclusion is threatened by ambiguity in the question asking in a superlative degree of the ‘smallest height that makes it true to say that a man is tall’.

Revised studies had four different case-studies; 2 replication studies and 2 revised studies (with modifications). Replicated vague and replicated crisp have larger gaps than the revised vague and revised crisp. Revised studies show that the gaps had disappeared significantly. No difference was found between truth and falsity for ‘old’ and ‘long’, but there was much glut value for ‘tall’, ‘age’, ‘height’ but again not for ‘length’.

As switching from Italian to English speakers could lead to such difference, we try to see if randomly selected Indian students conversant in English and Bengali would lead to any interesting find. From the data collected from 90 people it is observed that

(a) Indian subjects’ understanding is just the reverse;

(b) Gluts are more prominent than gaps;

(c) Adding qualifiers to predicates emphasizing the question hardly brought about any difference at all among individual participants;

(d) The range for simply framed predicates is lower than the range for predicates that have been more emphasized upon;

(e) There is a surprising consistency in gaps between height/age of men and women. Maybe, socio-cultural stereotypes about ideal people can explain such a trend;

(f) Another revealing find is that age and rural/urban background colours our perception;

(g) Also, notions about age, height, etc. seem to have been framed by our individual world experiences;

(h) Somehow the participants while answering had ethnicity in mind long before it was specified in the last question.

Accounting for Trends of Behaviour in Repeated Prisoner's Dilemma: A Regret-driven Learning Model

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Models of "learning from experience" have been widely used and demonstrated to be quite successful in different decision making scenarios including decisions under uncertainty, binary choice decisions, two-person zero-sum games, the games with unique equilibrium in mixed strategies and so on. The reason being that they mimic a very basic learning principle thought to be followed by human subjects, the reinforcement learning. As it suggests, whatever actions had positive outcomes in past are reinforced, in that the tendency to repeat those actions/choices is increased in comparison with other available alternative actions/choices. Such kind of adaptive strategy inherently leads the subjects towards more successful choices given an environment. But it has been previously observed that a model based on simple adaptive learning strategy fails to capture the experimental results observed in strategically more complex situations like repeated prisoner's dilemma (PD). The objective of this study was to address this issue and scale-up a learning model to predict human behavior in repeated PD. Such models fail to account for empirical observations in repeated prisoner's dilemma (PD) for the same reason that the Nash Equilibrium prediction fails to account for these results. That is, if the both (or every other player in multiple agents interaction) players are rational, attempt to chase "maximum possible payoff for an individual" results into mutual defection which have the worst possible payoffs for each of the player in a PD interaction. The subjects aware of such long-run outcome take a bounded rational approach, such that they choose to cooperate at a times though the strictly rational approach suggest that the defection is always the "best response" in a repeated PD interaction. We assume that such kind of a tendency in a repeated PD interaction is driven by the tension between the risk-dominant vs. payoff-dominant outcomes of the game, which is a purely bounded-rational aspect of human behavior in any decision making situation.

Based on the above assumption, we made an attempt to scale-up a perceptron-based (PB1) model to address the issue related to the lack of predictability of 'models of learning from experience' to account for repeated PD experimental results. In this investigation, "regret" term in PB1 have been modified such that it accounts for the tension between the risk versus payoff-dominant outcomes in a PD interaction. Our model simulations yielded significant predictions in two of the three test conditions. Simulation results show that the agents learn to cooperate over time with repeated interaction as observed in the experimental setups.

Field dependence-independence, emotional arousal and eyewitness memory accuracy

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Eyewitness account of a crime scene is highly dependent on human memory which is subject to various kinds of errors resulting from number of different reasons. A large body of literature suggests that the accuracy of eyewitness memory is challenged by a number of factors. These factors have been examined carefully in different studies. However, the eyewitness memory accuracy in relation to field dependent-independent (FDI) cognitive style remains less explored. Field dependent individuals (FD) have been found to differ from field independent (FI) individuals with respect to selection and organization of information available in the environment. It has been found that FI individuals, as compared to FD, organize information in more effective ways and perform better on learning and memory tasks. Such findings from different studies suggest a possible link between (FDI) cognitive style and accuracy of eyewitness memory. The present study examined and compared the accuracy of eyewitness memory among high and low field independent individuals. A total of 77 participants (34 male and 43 female) divided into FD and FI groups on the basis of Group Embedded Figures Test. Participants were shown a movie clip depicting a crime scene and were tested for their memory for central and peripheral details embedded in the video clip. Participants were also asked to rate their emotional arousal on mood adjective check list immediately after showing the video clip. Results of the study indicated that FI and FD individuals did not differ significantly in terms of their emotional arousal. However, FI significantly recall both central and peripheral details more accurately then their FD counterparts. The results are discussed in light of differentiation theory and are expected to provide new insight into the existing literature.

Is there Similar Decline in Visual and Spatial domains of Visuo-spatial Working Memory with aging?

Abstract

Visuo-spatial working memory (WM) decline with advancing age is a well established fact. But, there is no agreement on whether, a particular visual or spatial information declines as similarly as the visuo-spatial information as a whole. The present study addressed this question in a lifespan sample of 80 participants between 40-80 years old. Three specific tasks were designed for visual, spatial and visuo-spatial working memory. Random recall of different symbols only; and location only within 5 x 5 matrices of blank squares were used for visual and spatial domains, respectively. However, for combined visuo-spatial WM, a participant was asked to recall the specific symbol with respect to its location within 5 x 5 matrices of blank squares. The task started from a set of two symbols and continued up to a set of seven symbols maximum. All three domains were statistically analyzed using MANOVA. It was found that, a performance across visual WM was better than the spatial WM in each of the age groups. Moreover, significant differences were found between visual and spatial WM score [$F(4, 75) = 32.65$, $p > .05$]; visual and visuo-spatial WM score [$F(4, 75) = 34.43$, $p > .05$]. However, no significant difference was found between spatial and visuo-spatial WM score. In addition, the decline pattern of spatial domain was similar to visuo-spatial domain as a whole. This result revealed that the decline of visuo-spatial WM system with aging is primarily a decline of information associated with the location of the objects appeared in the visual system. Hence, possible interpretations of these findings are suggested and the theoretical and clinical implications considered.

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Key words: Visuo-spatial WM, aging.

Effect of Visual Feedback on Coordination of Grip Force and Load Force in Prismatic Precision Grip

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In precision grip, grip force (GF) is known to vary according to load force (LF) requirement (Johansson & Westling 1984). Some evidence suggests that GF is predictively controlled depending task goals, specifically it has recently been shown that this predictive control of grip force is influenced heavily by delayed visual feedback (Sarlegna, Baud-Bovy and Danion, 2010). In this study, we ask questions concerning the effect of visual feedback on the coordination between GF and LF. We ask subjects to produce tangential force on a mechanically fixed object so as to reach a target LF. Some time after the trial starts, the target level is changed in either direction. The subject is always instructed to keep the force level on the target. In a different manipulation, we artificially change the feedback, so that the subjects see feedback forces that are either more (or less) than what they are actually producing. This change is done at about the same rate as the change of the earlier manipulation (target change). We hypothesize that in the case where visual feedback changes, the subjects will increase grip force regardless of the direction of the manipulation. The results and implications shall be discussed in the conference meeting.

Neural mechanisms of verb processing: An ERP study with locative alternations.

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A verb is considered to be the binding agent in a sentence. It is only after the incorporation of a verb that a sentence assumes its complete meaning. Verbs with similar meaning can appear in different constructions, e.g. Content-locative and Container-locative constructions. The two constructions have different meaning frames where the focus is on the content in a sentence in content-locative construction whereas in the container-locative construction, it is the container that is being focused upon as the object of the sentence. Locative alternation rule suggests that if a verb can appear in a content-locative construction, then it can also appear in a container-locative construction, and vice versa. But this rule does not apply to all the verbs making the constructions anomalous and results in more errors. So far, very few studies have been conducted on the processing of verbs that are content-locative or container-locative. The purpose of the current study is to map the time course of sentential syntactic and semantic processing in the context of the use of these different types of verbs resulting in an anomalous or meaningful sentence construction. We investigate the way in which the content- and container-locative verbs influence the sentence processing in English using ERP as indices. We expected a N400 effect at the critical word (verb). The words from a sentence were presented in a sequence at the centre of the screen for 500 ms with an inter-stimulus interval of 700 ms. Sentences were either anomalous or not-anomalous (two way construction). The participants were required to make an acceptability judgment regarding the meaningfulness or appropriateness of the sentence by pressing a key. The data was analyzed and subjected to a 2x2 ANOVA. There was no significant difference in the judgment time of the two constructions. ERP results show a significant N400 effect in the form of a large negative waveform within the time frame of 360-670 ms after the critical word (verb) onset at the frontal electrode sites. We found a main effect for anomaly within this time window, $F(1, 16) = 4.720$, $p < .05$, where the anomalous constructions elicited a larger N400 amplitude in comparison to the two way (non-anomalous) constructions. The interaction effects were not significant. The effect is found in the frontal electrodes predominantly towards the left side of the hemisphere. Sentence processing is incremental and by using locative alternations the study shows how different verb types are processed in a particular sentential context.

Cube vision: Can blindfolded Rubik's cubing provide insights into the formation of mental imagery and its application to problem solving?

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The nature and formation of mental imagery, representation of non-present objects or events in the mind, and its role in performing vital cognitive tasks such as learning, thinking, reasoning and problem solving have long been subjects of research in cognitive science. Investigations into the nature of mental imagery can shed light on the representation of conceptual knowledge and storage of information in the brain, as access to conceptual knowledge is necessary in order to create a mental image. Although research in this area has primarily focused on visual imagery, mental images can also occur in the form of the other senses such as auditory images or olfactory images. A mental representation of one kind of sensory stimulus in the form of another sense has also been reported and could also potentially contribute to synesthetic experiences.

The Rubik's cube, a mechanical three-dimensional combination puzzle, can be an effective tool to study the utilisation of mental imagery in problem solving. In a classic 3×3×3 Rubik's cube, each of the six differently coloured faces of the cube are made up of 20 independently movable segments that can be moved to scramble the puzzle. For the puzzle to be solved, each face must be returned to a state consisting of only a single colour. It is noteworthy that certain individuals (popularly called "speed-cubers") can solve a Rubik's cube blindfolded in record time. A cuber has to memorise and recall the entire configuration of a scrambled cube in order to solve it blindfolded, which makes it a simple, but easily available, tool to study the relationship between vision and visual imagery. Our study focused on the memorisation techniques and the involvement of mental imagery in solving the Rubik's cube blindfolded by 55 expert speed-cubers worldwide.

Our results reveal the importance of mental imagery while solving a Rubik's cube, as seven out of the eight distinct kinds of memorization and recall techniques, which we documented among the cubers, involved vivid mental imagery. The most popular technique involved assigning a letter to each colour on each cubie (one of the twenty smaller cubic pieces that form the entire cube and which can have either two or three colours a piece) and then assigning images to pairs or sets of letters and storing these mental images, either as they were or linked with objects inside a room or along a planned route map where these objects were used as landmarks. Procedures such as learning sounds generated by these letters, assigning numbers or even images instead of letters, and memorising pieces directly without assigning numbers, letters or images were also observed.

Significantly, there was notable variation in the strategies used for memorising the edges and the corners. Moreover, 45% of the blindfolded cubers that participated in our study were able to solve more than one scrambled cube in a row. In this complex situation, they depended largely on images generated by letters assigned to the colours on the cubies. Although several studies have shown that sustained practice using mental imagery can enhance the performance of a particular activity, our study failed to show any correlation between the time spent in prior practising and the speed with which the cube puzzle is solved blindfolded. We emphatically suggest the strong potential of detailed investigations into mental imagery, the processes that underlie its formation and its ability to solve cognitive problems using the blindfolded solving of the Rubik's cube puzzle, an experimental system that has never before been explored.

The effect of task load and distraction on discrimination.

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Abstract:

Background

Potentially threatening negative stimuli are more rapidly processed and are generally more difficult to ignore than neutral ones. The amygdala has been implicated in the detection of these emotionally significant stimuli and the prefrontal cortex (PFC) and anterior cingulate cortex (ACC) in attentional control over these stimuli. Empirical support has been obtained for an inverse functional connectivity between the amygdala and prefrontal cortex (PFC). The present study examines the effect of task load on processing resources and the extent to which emotional stimuli: negative, unpleasant pictures produce interference on a discrimination task that demands attention. To what extent does task load have an effect on top-down attentional control mechanisms and bottom up processing of distractors, particularly emotional ones?

Method and Material:

Thirty four college students participated in this study, in which distractor presence, distractor valence (negative arousing vs. neutral pictures), Gabor patch sinusoidal grating orientation of the patches presented to the left and right of the centre of the picture (match/same vs. nonmatch/different) and attentional load (angular difference of the sinusoidal gratings on nonmatch trials: easy 90˚ vs. difficult 6˚) were manipulated. Neutral pictures consisted of photographs of people, animals, human body parts and the negative arousing pictures consisted of photographs of mutilated bodies of humans and animals, attack and disgust scenes selected on the basis of a prior study. Distractor presence was the between subjects variable.

Each picture was presented in the centre of the screen flanked by two Gabor patches. Participants were instructed to look at the centre, ignore the task irrelevant picture and respond as quickly and as accurately as possible, whether the sinusoidal gratings with a 90˚ or a 6˚ difference in orientation (easy vs. difficult) were the same or different. The order of the unpleasant and the neutral pictures was randomized within the block. The difficulty of the discrimination task within each block was fixed. Each block had the same number of match and non-match trials and the same number of unpleasant and neutral pictures. Feedback was given to the participant during training. The order of the experimental blocks was randomized across participants.

Results:
No significant differences were observed on speed of response (RT) across the conditions. However significant differences were obtained on level of accuracy. Using signal detection theory analysis, it was observed that sensitivity (d') was greater on the easy blocks and there was a shift in response criterion; from liberal on difficult trials to conservative on easy trials. There was greater accuracy when there was no distractor present and on the easy block (low load).

Accuracy was also higher when the Gabor patch orientations matched. There was a block (load) x grating orientation (match non-match) interaction effect. Accuracy was lower on difficult, high load, non-match trials (6˚ difference between left and right Gabor patches), accuracy was highest on easy, low load, non-match trials (90˚ difference between left and right Gabor patches).

There was a significant interaction between distractor valence (negative/neutral) and attentional load (easy/difficult block). The interaction between distractor valence, attentional load and grating orientation match approached significance. Accuracy was lower on difficult, high load, non-match trials whereas on the easy block, there was no significant difference in accuracy as a function of grating orientation match or distractor valence.

The high exogenous attention load of the main task, specifically in the presence of distractors in the difficult non-match condition, may have drained processing resources and capacity available for active control and led to a criterion shift in response.

Conclusion:
Although the load of the main task affects distractor processing, further work is necessary to understand how distractor relevance and participant motivation for engaging in the main task, modulated by individual differences, influences performance.

keywords: attentional load, emotional distraction, discrimination

Effect of instructionally induced affective arousal on time perception

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Though the progressing of objective time is linear and is in constant unites, there are plenty of research findings to show that temporal judgment about passing of an event is based upon a number of factors including characteristics of the perceiver (such as age, personality traits, degree of stress and arousal), participants' activity during a time span (cognitive load of task) and characteristics of the events to be judged (such as presentation duration, sensory modality, complexity etc.). Literature in this area also suggests that perception of time is also affected by variations in external stimulation and by the cognitive and affective state of the individual. However, efforts to explore time perception in relation to the subjective emotional state and emotional nature of the event (external stimulus) have been very few. Further, such studies have used stimulus with different affective valance where the comparability of the stimulus is a serious question. Taking the aforesaid gaps into account the present study examined the effect of emotional arousal, generated through differential instruction about a single ambiguous stimulus, on perception of time duration using prospective and retrospective paradigms. Forty adults were asked to listen to a 20 second audio clip, affective valence of which was altered by providing different pre-information about the nature of the sound clip. For one group of participants it was told to be intrusive and anxiety provoking while in for the others it was told to be neutral in valence. After listening to the clip the participants were asked to reproduce the time duration of the sound clip and to report their current arousal level and affective state. For half of the participants the experiment was conducted under retrospective paradigm while for other half it was conducted under prospective paradigm. Results revealed that differential pre-information about the nature of the sound clip resulted in different arousal level and affective state among the two groups and the estimated time duration of the audio clip was found to be significantly lower among participants experiencing negative affective state and higher arousal level as compared to their counterparts. Further, such differential effect of affective valence and arousal on time perception was observed only in retrospective paradigm. These results have been discussed in view of existing theories and are expected to contribute significantly to the existing literature.

Is There Such a Thing as a Sense of Agency?

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he ‘Sense of agency’ is operationally understood as (a) the experience or judgment of ‘me’ or some ‘other’ as the cause of action, and/or (b) the experience or judgment of intensity (from low to high) of agency/control over action. The scientific research on sense of agency took impetus by the research on neuropathological conditions such as Schizophrenia and Anarchic hand syndrome. A model called, the ‘Comparator model’ (originally proposed to explain motor control), is being proposed to explain the distorted sense of agency in these pathologies, and, this model is extended to explain sense of agency in normal people too. A match between the predicted (sensory) outcome of an action and the actual (sensory) outcome of that action, which is implemented by the (neural) comparator mechanism, is implicated in sense of agency. But, researchers such as Daniel Wegner argued that the sense of agency is elicited by processes that cannot solely be explained by the comparator model of motor control. Present theoretical consensus is that both predictive/feed-forward comparator processes as well as postdictive action processes (such as the action effects) together influence the sense of agency. Some researchers such as Matthis Synofzik opine that depending on the situation, sometimes it is the predictive cues that are given high weighting or priority over postdivtive cues, while in some other occasions it is in reverse i.e., postdictive cues are highly weighed over predictive cues. But it is still not clear how the relative weighting between predictive and postdictive cues works.

In the sense of agency literature, the sense of agency is understood to exist in two different ways – (1) as a “feeling” of agency, and, (2) as a “judgment” of agency. In this paper, however, we doubt whether there is such a thing as sense of agency at all – either as a feeling or as a judgment. We argue that researchers “assumed” the concept of ‘feeling’ of agency to describe symptoms in neuropathological conditions such as Schizophrenia and Anarchic hand syndrome; and, they are wrong in their assumption as the ‘verbal reports’ of the patients may not represent ‘feeling’ of agency. We doubt whether the implicit measures of feeling of agency such as sensory attenuation and intentional binding may be studying the ‘feeling’ of agency as such. Also, the description of the concept of ‘feeling’ of agency is confounded with the concept of ‘intention’. We also question the credibility of the concept of ‘judgment’ of agency. We argue that the verbally reported agency judgment may not be about agency at all; the agency attribution could equally be explained by concepts such as self-serving bias over the valence – either positive or negative – of the action outcome, understanding of causation, sense of effort and proprioception etc.,

We argue that the concept of sense of agency and its explanation by forward/comparator model and multiple weighting models etc., are redundant, since the existence of sense of agency – either as a feeling or as a judgment - is questionable. We further argue that, the assumption of sense of agency (and models to explain it) and proposed neural correlates of sense of agency are due to ambiguous definitions and misconceptions of experimental paradigms and models in sense of agency research.

Valiuating Measures of Complexity of Connectivity of Brain Using Grasshopper Model

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There is a strong correlation between the behaviour of the organism and the connectivity of the network of neurons, the anatomical and cellular physiology of the neurons. Considerable technical advances, especially over the last few years, have led to substantial improvements in neuroimaging techniques. This has allowed scientists to gain ever deeper insights into neuronal brain structures and their functional circuitry. Nevertheless, considerable challenges still exist, when it comes to the study of the neuronal functions within such a complex system as the vertebrate brain. The degree of accuracy, when investigating the mammalian cortex, generally does not reach below the level of neuron-classes. However, understanding neuronal microcircuits depends on a detailed analysis of the physiology and morphology of individually identified neurons and their connectivity to other neurons. Many metrics exist that connect complexity of the anatomical network to that of functional network and behavior. To verify these metrics, the networks need to be manipulated.

Small organisms like insects have a comparatively small number of neurons that are easily accessible for measurement and manipulation. Therefore, insects serve as popular model systems in neuroscience. The brain of a grasshopper is relatively large among insects and is amenable for in vivo investigations. Many exciting results about the visual system (Rind, 1987, 2002; Simmons, 2002), the olfactory system (Laurent, 1996, 2002), brain development (Ludwig et al., 2001; Boyan et al., 2003), endocrine functions (Veelaert et al., 1998), the control of flight and walking (Burrows, 1996), and mechanisms of spatial orientation (Homberg, 2004; Pfeiffer and Homberg, 2007; Heinze and Homberg, 2007) have been learned and discovered using this system. Despite these exciting results that have been achieved using this model organism, we have very minimal information regarding the detailed anatomical connections of the invertebrate brain. Moreover, whatever information is available is scattered and there is no particular database that can give this information. There has been some effort to create databases with regard to distribution and relative locations and sizes of neuropils and anatomy of typical neurons of the brain for insects like silk moth, honeybee, and cockroach.

We have partly characterized the neuroanatomical connectivity of a grasshopper brain by tracing methods, intracellular recordings and fills. We are making schematics and database having this information that can be easily accessed and queried to analyze the connection strengths between different brain regions. We are using this database to compute metrics of complexity of the connectivity in a grasshopper brain and compare it to the data available from other organisms.

Embodiment and Consilience

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The search for consilience of knowledge has got a new momentum with the thesis of embodiment making inroads into most areas of cognition. Though the term embodiment is used in various ways a common theme that can be delineated from the variegated usages is that brain is not the sole locus of cognitive resources. Questioning the hegemony of the skin and the skull, embodied thesis can be seen as being able to meet the common frontier that E O Wilson refers to as the place for consilience. The present paper discusses why embodied realism—the metaphysical thesis arising out of embodied approach to cognition-- is a plausible framework to have vertical integration among different disciplines. At the same time, embodied approach is intuitively implausible primarily because of the inborn dualism we carry in the form of inveterate ways of understanding ourselves. The subsequent part of the paper carries forward this line of thinking and offers consiliation of knowledge distilled from contemplative traditions with that of embodied cognition. It is suggested that ways to overcome this inborn dualism lies in certain practices which can reprogramme the focus of attention. Recently, there have been a plethora of studies on mind wandering and mindfulness and they offer a plausible framework to address these issues which, in turn, can give rise to an understanding of the self which does justice to the way cognitive processes are understood scientifically. Thus the task of making the self portrait less of a caricature is common to that of contemplative traditions and cognitive sciences.

Learning from Written Context: Cognitive Linguistic Perspective

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Incidental learning from context during free reading is the major mode of vocabulary acquisition during the school years, and the volume of experience with written language, interacting with reading comprehension ability, is considered as the major determinant of vocabulary growth (Nagy et al., 1985). Reading is an important area for children to independently build complete and partial word knowledge. The concept of partial word knowledge is associated with the type of information that is involved with knowing a word, specifically, phonological, semantic, syntactic, morphologic, and (in literate individuals) orthographic information. A thorough analysis of children's errors may be helpful for understanding the development of word knowledge in children who find reading a complex task such as children with dyslexia and slow learners.

Impaired ability to store semantic information in children with dyslexia due to weak or diffuse semantic representations are suggested to be one of the reasons why children with dyslexia have difficulty in word knowledge (Alt, Plante, & Creusere, 2004; McGregor, Newman, Reilly, & Capone, 2002). McGregor et al. (2002) studied the semantic representation of age-appropriate words by children who had language disability. Children named, provided definitions, and drew stimulus words. The group with dyslexia made more naming errors than the control group, and both groups made more semantically related errors than other error types.

Alt et al. (2004) concluded that children with dyslexia had weak phonological representation of the word labels. These studies suggest that these children have primary difficulties learning semantic information, in addition to phonological information. Furthermore, the locus of difficulty may be in learning or storing phonological and semantic information, rather than retrieval of information, for words learned through the oral-auditory channel. These results have important implications for how best to address the word learning challenges of children with reading difficulties.

Relevant to this study, the detailed assessment of a child's definition of novel words after reading will provide insight into why these patterns of error occur and are they in a continuum for typically developing, children with dyslexia and slow learners.

Aim of the study

The aim of the present study is to study the pattern of learning to read non words in the presence of a context in a typically developing child, a child with dyslexia and a slow learner.

Method

Participants: The participants for the study included three children aged 9 years 5 months. These children included a typically developing child (TDC), a child with dyslexia (DYS) and a child diagnosed as slow learner (SL). All the children were age matched.

Test material: Two reading passages each including 5 target non-words were used.

Procedure: Each child was asked to read the experimental reading passage in silence following which the oral definition assessment was given. The oral definition given by children will be orthographically transcribed and scored using a 3 point rating scale.

Scoring and Analysis: The oral definition responses were categorized into two broad response types: associated and unrelated. These broad categories were further divided into sub categories-indeterminate, false, sentence, and phonological- and three associated sub categories-semantic, syntactic, and substitution. The number and proportion of error responses occurring in each subcategory for typically developing child, child with dyslexia and child with slow learning were coded and tabulated and then subjected for appropriate statistical analysis.

Results and Discussion

Analysis of results indicated that all the three children showed varied error patterns for oral definitions for non words presented in a context. It was found that while TDC showed semantic substitution errors, the child with dyslexia chose a close phonological relative while defining the non words and on the other hand, the slow learner showed greater number of errors but with similar pattern as seen in the child with dyslexia. Even though the observations indicated that the participants inferred the holistic meaning of the passages, the gaps in understanding can be attributed to diffused representations in the long-term memory of the episodic buffer. This could also be due to a deficit in the interaction between the verbal short-term memory (VSTM) and the central executive mechanism which is often observed in children with dyslexia (Baddeley, 1990; 2003).

Conclusions and implications of the study

From a cognitive-linguistic perspective, the analysis and observations of the present case studies indicate that the pattern of learning to read non words in the presence of a context is varied and of a different nature in a typically developing child, a child with dyslexia and a slow learner.

The present study would contribute to the existing evidence of the pattern of vocabulary development in children. It would highlight the novel word acquisition through reading in children with dyslexia in the Indian context where English is a second language yet is indispensable for formal communication. The study will help the clinicians to assess the pattern of errors made by children with dyslexia and diagnosed as slow learner and accordingly carry out intervention programs. An insight into the error patterns whether lying on a continuum for the aforementioned disorders can be deduced from this study.

Natbral Language Typing Frequencies

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The frequency of occurrence of alphabets and various combinations of alphabets i.e. n-grams in English language has been well studied. We study whether there is a correspondence between statistical properties of the natural language correlate with the typing speeds. Specifically we test for single letter frequencies and bi-gram frequencies. A text was selected from an English language corpus consisting of 1712 characters to be typed in all. This was presented in the top half of the screen with wrapped text as a paragraph. 14 participants were asked to reproduce the text in the bottom half of the screen. A sequence alignment algorithm was used to match the typed text with the target text. First, we performed calculation of letter frequencies and bigram frequencies for the text used in the experiment. We had a total of 1403 valid alphabetical characters after ignoring the punctuation marks. This comprised of 36 unique alphabets that were case sensitive. Mean reaction times for these alphabets were found to be correlated with the letter frequencies ($r = -0.41$, $p<0.05$). Similarly, of the 1711 possible bigrams, we had 1127 valid bigrams after ignoring word boundaries and punctuation. The number of unique bigrams were 215. The correlation between corresponding reaction time for the second letter of the bigram and the bigram frequencies was also found to be negatively significant. ($r=-0.2$, $p<0.01$). We suggest that the correlations of letter frequencies and typing speeds reflect the concordance of motor programs with language skills.

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ABSTRACT(Revised)

Koinophilia and its Exaptation: A Key Trigger to Cognitive Development ?

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Since the overwhelming majority of unusual features (physical, behavioural, auditory and olfactory) are maladaptive, sexual creatures will almost certainly have evolved sensory systems, over a period of billions of years of sexual selection, for avoiding aberrant mates. This phenomenon, termed *koinophilia*, which has been, rather surprisingly, relegated to near obscurity, could have served as an early evolutionary trigger for the development of the sensory apparatus, chiefly olfactory, visual and auditory, which helped sexual creatures to discriminate against aberrant mates. "Features that cannot fail to be noticed by potential mates viz. social behaviour, body morphology, colouration, song and …. motor function are most likely to be constrained by koinophilia", said Koeslag, the protagonist of koinophilia (Koeslag,1990) Koinophilic mate selection maintains phenotypic conservatism among sexual forms, leads to sexual isolation, canalise the species, prevent non-cryptic mutations from spreading, create aversion to phenotypic novelty and thereby stabilise social animals against mutants. (Koeslag,1990, Koeslag 1994, Koeslag 1995)

Thus, the koinophilia-driven mate-choice probably kick-started the early cognitive development by unifying cognitive and affective domains: first by integrating visual, auditory and olfactory stimuli into a wholesome experience for directing mate choice; and subsequently the affective domain, which developed by generating a strong affinity for modal features, together with aversion for deviations from the norm.

While natural selection can explain the development of all organisms, the cognitive sophistication in humans has been too quick to be attributed to evolutionary adaptation alone. Gould argued that a process of *exaptation* (coopting of previously evolved features for novel purposes) is critical to the unique human cognitive machinery, which stems from the reuse of neural circuitry for multiple cognitive functions (Skoyles, 1999). Thus koinophilia-driven abhorrence for phenotypic aberrations not only engendered an infatuation for modal features (experienced as attractiveness and described as beauty by humans) but also facilitated detection of subtle variations from the norm, chiefly in outliers ; thereby enabling the identification of individuality, a major survival need in large social groups. Unsurprisingly, the face fusiform area (FFA), believed to be dedicated to face recognition, has also been found to play a role in evaluating attractiveness. The affinity for modal mates, experienced by man as 'attractiveness' or 'beauty' cannot be sidelined because of the overwhelming emotional responses 'beauty' evokes in man. That emotional expressions could be predicted from the patterns of neural activity recorded in FFA seems to supports this argument(Harry et al 2013).

The extended role of the FFA towards non-innate cognitive skills such as expert pattern recognition (cars, birds, greebles etc.) understanding degraded speech and recognizing board patterns in chess games further support neural reuse. Cognitive impairment reduces functional connectivity with FFA (Bokde et al 2006). Recent reports suggest functional subdomains within FFA including one for functional communication verbs! Neural plasticity facilitates the exaptationary expansion of cognitive functions in the context of sensory sophistication spurred by koinophilic mate selection. Thus the neural circuits that evaluate mate fitness could have been expanded and redeployed towards a plethora of higher cognitive functions in humans, including the highly evolved aesthetic sensibility and the potential to acquire non-innate cognitive skills.

Koinophilia-driven cognitive development is fundamental to recognizing one's own species, because understanding the external phenotype of one's own species -- the prototypical category in the biosphere -- is the *sine qua non* for survival. The ability to distinguish one's own species as a 'category' probably developed into a more general ability to categorize living and nonliving objects in the world. When such 'categorization' is coupled with the Exception Report mechanism (Unnikrishnan 2009, Unnikrishnan 2012) that helps within-category recognition of individuality, koiniphiliic mate-choice could have jumpstarted a basic feature of 'category perception' that predates humans.

A recent review of cluster analysis of brain activity suggests that the FFA contains cell populations that have the potential to represent multiple categories (Cuckur et al 2013, Ross et al, in press) That the FFA is the common denominator, not only in a variety of experiences and mental representations, but also in the execution of several interrelated complex tasks, does not seem surprising, given the expansive evolutionary history of sexual selection in general and the rapid exaptation-triggered developments specific to humans.

Keywords: koinophilia, face fusiform area, exaptation, exception report of face recognition, evolution, category perception

Visuo-spatial recall and reproduction of geometrical shapes and math equations as a function of presentation style – static, block and animation

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Abstract

An effective mode of presentation of learning material is of interest to technologists and cognitive scientists. Topics requiring recall and reproduction of complex drawings like in engineering, sciences or geometrical shapes at the school level require thorough investigation so as to customize presentation of diagrams. Towards this, a study to compare visuo-spatial constrcution and reproduction ability of stimuli presented in static, block/sequential and animation mode was conducted. Seventy-one 4^{th} and5^{th} grade students of a government school were shown simple 2-D geometrical shapes (Figure 1) and mathematical equations (Figure 2) using a projector. The participants were divided into three nearly equal groups and the order of presentation of the modes was mixed to account for possible higher recall rate of the last rendered image. The participants were asked to draw (paper and pencil) from memory the geometrical shapes and select the correct mathematical equation from a multiple choice questionnaire. For the geometric shapes, scoring was on the number of lines, nodes, axial orientation and relative proportionality and identification of the exact spatial position of a digit or operation was the metric for the math equations. The animated mode of presentation of the geometrical shapes and math equations scored high (Figure 3) in conjunction with previous studies (Mayer et al.,2003, Moreno & Mayer, 2007, Hoffler & Leutner, 2007, Goldstein et al.1982,), as action, even that which is observed, emphasizes motor actions . Interesting comparison is between the other two modes, where we noticed that for the geometrical shape slightly complex and not very familiar (Figure 1c) , the static mode of presentation scored higher in recall than the same presented in block or sequential mode, whereas for a less complex figure 1b the average score higher for block than static and nearly equal to animation. A similar result also noticed for the asymmetrical math equation (Figure 2c). The lower scores for block mode for shapes with depth suggest that the process of 'stitching' two parts of a figure with non-connecting nodes or symmetry in edges increases the visual processing cognitive load compared to assimilation when the whole figure is presented as a static complete image. The 'explosion' or block type of presentation is unable to provide temporal information as is available for animation (Lowe ,1999) while the human cognition seems to be able break-up components and sub-components and form hierarchical mental representations ((Narayanan and Hegarty 2002) with a static whole image. The findings are particularly relevant when presenting complex

diagrams like engine drawings, where ‘explosion’ style of presentation is commonly used as animation is data intensive. The findings from this study also raise interesting questions on perception of depth.

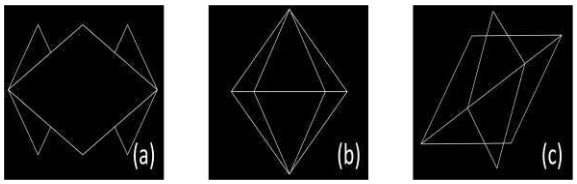

Figure 1: The geometrical shapes used as the stimulus.

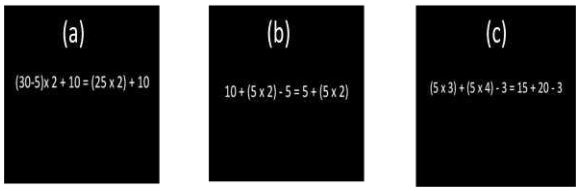

Figure 2: The math equations considered for this study.

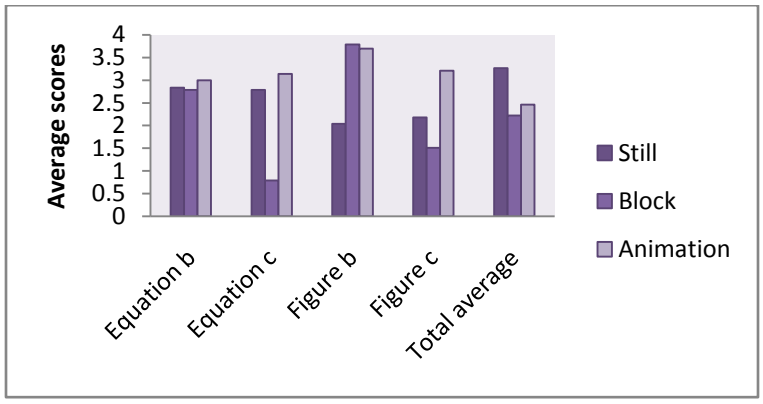

Figure 3: The average scores for each presentation mode for figure (b & c) & equation (b& c) and the average across all modes.

Discussion and conclusions

The comparison between the ‘block’ mode with that of animation and static presentation is interesting to understand mechanisms employed by the human brain to process, store and ‘stitch’ together visual information presented in discrete parts. From the preliminary study, it can be deduced that the steps involved in ‘stitching’ of shapes with depth is more involved than the ability to form a continuous linked mental representation and assimilation of the same. Further

experiments with varied set of shapes are required to check the role of nodes and edges as anchoring points. An extension would be to look at complex visual images like faces.

Acknowledgement

We acknowledge the help of Suvarna Rekha for help in conducting the experiment in the school. Also acknowledge the government school, Madhapur, Hyderabad for allowing us to conduct the experiment.

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Vyangya and its Implications on Contemporary Studies of Non-literal Usage of Language

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The field of Indian Poetics posits Dhvani or Poetic Suggestion as being central to aesthetic enjoyment. Dhvani is the very special sense of words in poetry, which is neither the literal sense nor the extended sense (commonly, and loosely, called 'metaphorical sense') and co-exists with one or both of them. The more generic category of this context-dependent, tertiary level of meaning is vyangya, which can be thought of as a super-set of dhvani (since dhvani is a special case of vyangya). In Indian poetics, dhvani has been studied in great depth and detail; but not so vyangya, since it was not of particular interest to the poeticians.

Vyangya and the phenomenon of vyanjana are of great interest to students of language for one good reason at least: it is a phenomenon which widely occurs in language that is even in common use. Though the theorisation has been done in a particular language (viz. Sanskrit), the applicability is universal, i.e. for all languages.

In this paper I propose to show a possible classification of vyangya which can help see the patterns that emerge in the understanding of the way the phenomenon works. Since this is a widespread phenomenon in linguistic exchanges, it can be the object of study in Cognitive Linguistics and Pragmatics.

Role of divided attention on motor adaptation with/without feedback based error correction

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Human behavior critically depends on correctly judging the origin of afferent information as resulting either from the external world (exafference) or from one's own actions (reafference). It is suggested that for this distinction the brain resorts to internal predictions about the expected sensory consequences of one's own action. However, one and the same action can have different sensory consequences depending on the context or changing body conditions such as fatigue, aging, or disease. But, how does the brain still adequately inform perceptual evaluation? In previous studies on self-action perception, it has been suggested that the perceptual awareness of one's own hand movement is an inferential process based on a comparison between internal predictions of the upcoming sensory consequences and the actual sensory feedback. If the reafferent feedback about one's hand movements is constantly perturbed, predictions on one's sensory action outcome would be correspondingly updated (adaptation). However, adaptation of movement can be driven by the difference between expected and actual sensory consequences of movement (task-relevant error), or the difference between planned and actual motor performance (sensory prediction error). It was not clear until recently whether adaptation occurs due to task related errors, sensory prediction errors, or both. Although it was shown that adaptation occurred regardless of whether the perturbation is relevant to the task, and it is independent of feedback control; it is not in line with the predictions of Optimal Feedback Control (OFC) theory of motor control. To explore the mechanisms and differences in adaptation depending on the relevancy of error, in the present study, we used different cognitive load in both arc and ray adaptation procedures. We hypothesize that if two kinds of adaptation are different then cognitive load may have differential effects on them. Our results suggest that high cognitive load during adaptation does not affect the feedback controller, but it does affect adaptation similarly in both kinds of procedures. Moreover, we have found similar effects of load on self-action perception. Overall results suggest that OFC considerations alone cannot underlie the present human motor adaptation; there needs to be adaptive processes that maintain values of expected movement.

The Nature Of Word Generalization In Learning Novel Concepts

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Abstract

We conduct a word learning experiment using artificial word categories to study the human word generalization behaviour. We hypothesize that the word generalization behaviour will be based on similarity even when the positive examples of a word share a defining feature. The results of the experiment support our hypothesis.

Introduction

Fast-mapping is the ability—that humans have—to learn a new word from just a few examples. Studies have shown that this fast-mapping can be modelled using Bayesian inferencing in a structured similarity based hypothesis space (Tenenbaum & Xu, 2000; Xu & Tenenbaum, 2007; Abbott, Austerweil, & Griffiths, 2012). The studies conclude that human word generalization for natural category objects is mostly similarity based. By similarity based generalization we mean that a word is generalized to a new object based on its similarity with the positive examples of the word. But can we say the same thing for an artificially constructed word category that clearly has a set of defining features?

A definition based model of word generalization would try to check if the new object satisfies a set of conditions that is satisfied by the positive examples of the word. We hypothesize that the word generalization for an artificial word category—having a set of defining features— will still be based on similarity and not on the set of defining features.

In our word learning experiment we use artificial objects having boolean features. We use Formal Concepts (Ganter, Wille, & Wille, 1999) for our definition based generalization. For Similarity based generalization we use the similarity measure given by a Linear Regression Model.

Experiment

In this experiment 24 participants were shown six positive and six negative examples of a word. The participants were then asked whether the word applies to a new example. The generalization behaviour was then compared with the Formal Concept based generalization and Similarity based generalization.

Figure 1 shows a sample stimulus that was used in our experiment. The top row lists the positive examples of a novel word. The middle row lists the negative examples and the last row lists the test examples. The test examples are shown

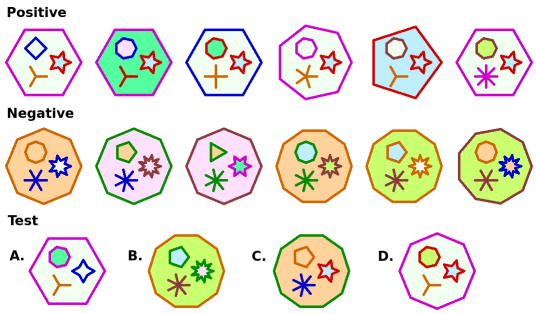

Figure 1: The figure shows a sample stimulus. The top row lists the positive examples, middle row the negative examples, and the bottom row the test examples, for a novel word. All the positive examples have a five pointed blue star with a red border. The participants are shown the test examples one by one and asked if the word applies to the test example.

to a participant one at a time. The participant is then asked whether the word—for which the positive and negative examples are shown—applies to the test example.

In Figure 1 all positive examples contain a five pointed star with a blue background and a red border. This is the only feature that is present in all the positive examples and not present in any of the negative examples.

If the generalization behaviour is based on a set of necessary and sufficient conditions then the experimental results should show that more people generalize the word to test examples C and D compared to test examples A and B. This is because among the test examples only C and D contain the star with a blue background and a red border. On the other hand, if the generalization behaviour is based on similarity then the experimental results should show that more people generalize the word to test examples A and D.

Figure 2 shows another sample stimuli. We used six stimuli similar to those shown in Figures 1 and 2. Table 1 lists the four types of test examples corresponding to each stimulus. There were 24 (6×4) test questions in total.

Results

Table 2 shows how the participants generalized a word to a test example belonging to each of the four types shown in

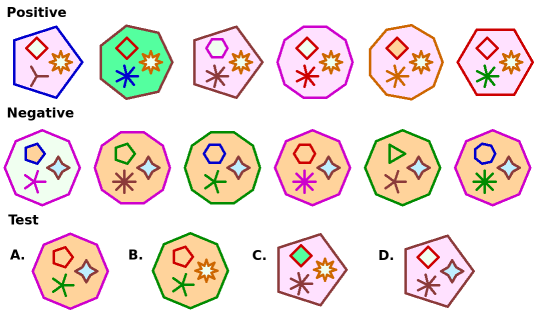

Figure 2: The figure shows another sample stimulus. The top row lists the positive examples of a novel word, middle row the negative examples, and bottom row the test examples. All positive examples have an eight pointed star with a white background and orange border. The participants are shown the test examples one by one and asked if the word applies to the test example.

Table 1: The four types of test examples for each stimulus

	Similar to +positive examples?	Satisfies the Formal Concept?
Type 1	Yes	Yes
Type 2	Yes	No
Type 3	No	Yes
Type 4	No	No

Table 2: Table shows the result for each type of test example. There were 144 responses corresponding to each test example type. Frequency column shows the fraction of the trials for which a word was generalized to a test example type. Percentage column shows the percentage corresponding to the frequency value.

	Frequency (out of 144)	Percentage
Type 1	122	84.7%
Type 2	108	75%
Type 3	53	36.8%
Type 4	30	20.8%

Table 1. There were 144 responses corresponding to each test example type. The difference between the Type 2 test example frequency and Type 3 test example frequency was found to be statistically significant using the Wilcoxon Signed Ranks Test (W (21) = 24, p $<$ .001). The results show that a word is generalized more frequently to Type 1 and Type 2 test examples compared to Type 3 and Type 4 test examples.

Figure 3 shows the 24 test examples divided into two groups —those that satisfy the Formal Concept and those that do not. We find the average percentage of participants who generalize a word to the test examples in each of these two groups. If the generalization behaviour is based on Formal Concept then we would expect the average percentage to be

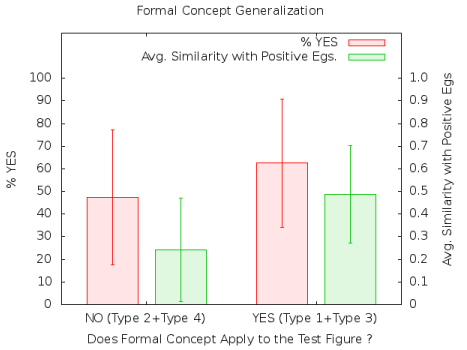

Figure 3: The 24 test examples are divided into two groups —those that satisfy the Formal Concept and those that do not. The figure shows the average percentage of participants who generalized the word to the test example in each group. The figure also shows the average similarity between a test example in a group and the positive examples of a word.

closer to 100% for one group and closer to zero for the other. Figure 3 shows the average percentage of participants who generalized a word to the test examples in each group. We see that for both the groups the average percentage is closer to 50%. Spearman Rank Correlation Coefficient between the generalization made by the participants and the generalization based on necessary and sufficient conditions was found not to be statistically significant $(r(574) = .15, ns)$.

Figure 4 shows the 24 Test examples divided into two groups based on their similarity to the positive examples of a word. If the participant generalization behaviour is based on similarity then we would expect this percentage to be closer to 100% for one group and closer to zero for the other. The data in Figure 4 confirms this. Spearman Rank Correlation Coefficient between the generalization made by the participants and the generalization based on similarity was found to be statistically significant $r(574) = .51, p < .001)$.

Figure 5 shows how the percentage of participants who generalized a word to a test example varies with the average similarity between the test example and the positive examples. In the figure we see that the percentage increases with the average similarity. The Spearman Rank Correlation Coefficient between the two variables was found to be significant $(r(22) = .87, p < .005)$.

Conclusion

The above results show that the generalization behaviour for the word learning experiment is better modelled using the similarity based generalization compared to a definition based generalization.

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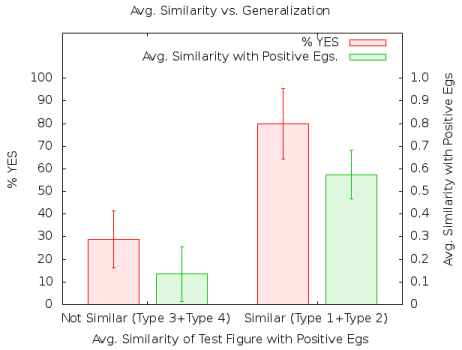

Figure 4: The 24 test examples are divided into two groups based on their average similarity with the positive examples. The figure shows the average percentage of participants who generalized the word to the test example in each group. The figure also shows the average similarity between a test example in a group and the positive examples of a word.

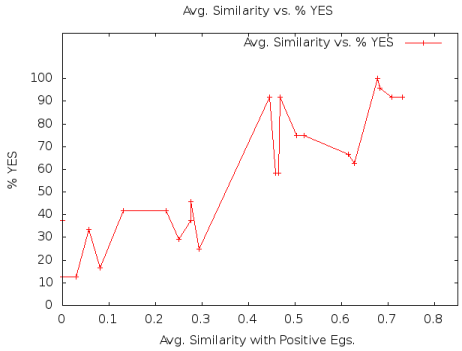

Figure 5: Figure shows how the percentage of participants that generalized a word to a test example varies with the average similarity of the test example with the positive examples. Spearman Rank Correlation Coefficient is statistically significant $(r(22) = .87, p < .005)$.

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A Paradigm to Study Expectation Violation Using a Grasshopper model (Hieroglyphus banian)

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Animals recognize and identify objects in their surrounding environment rapidly and seem to do so with ease. They also engage in goal directed behavior flexibly in response to their natural surroundings. Most animal behavior has expectations about the consequences and their perception has expectations about future stimuli. Behaviors in animals, including humans, require preservation of favorable variants and rejection of injurious ones. Nervous systems must therefore determine the probable rewards and punishments associated with the available options around them in order achieve desired goals or avoid undesirable outcomes. In other words, goal directed action selection motivates action by integration of (a) an expectation that a specific action will have a specific outcome and (b) a desire for that outcome. Additionally, the term goal-directed is often applied in a motor context to action which is organized with respect to a target object, manipulation, or posture.

Presence of definite neural correlates when such expectations are violated has been shown in humans across different modalities such as visual, auditory, etc. For example, it is known from several studies in humans, based on ERP (especially the oddball paradigms) and fMRI techniques, that there are characteristic changes in voltage deflections and haemo dynamic responses associated with each kind of violation. The P600, P300 and N400 are some of the examples which are known to elicit positive and negative voltage deflections when semantic and grammatical errors occur either in sentences, words, pictures, etc that are presented both in the visual and auditory domains. Such neural correlates have been used to measure expectation violation when conscious report is not possible. How expectations are set up and how are violations of these expectations detected and encoded? How do they affect the consequent behavior or perception? In order to understand these questions we need to develop a reliable behavioral paradigm to obtain detailed measurements at a neuronal level. Our aim is to establish an experimental behavioral paradigm in the simple model organism, grasshopper (Heiroglyphus banian), and study expectation-violation, its neural correlates and the mechanisms involved in the same.

Insects show movement of limbs in an alternating tripod gait when walking on smooth or even surfaces. However, this normal walking pattern or behavior is altered when they come across impediments in their walking terrain such as a gaps, chasms, obstacles, steep surfaces, slippery surfaces, etc to name a few. In this study, we aimed to develop a gap encountering paradigm in the grasshopper system in which we can monitor the expectation (no gap) and violation of the expectation (gap). We test the feasibility of obtaining measurements from neurons in relevant pathways while the organism is performing this behavior.

We have been able to design a simple setup to perform walking experiments on grasshoppers and simultaneously record videos for further analysis. We used the videos to track and quantify different features of their limb movements (stride lengths, stride velocity, and trajectory of the forelimbs just before reaching the gap). Using this data we have set a standard criterion to show if expectation was violated on reaching the gap. Currently, we are still working on extracting other features that can be quantified as mentioned above and on designing a set up to record electrophysiological data from different regions of the brain in a walking grasshopper.

Imaging Speech Dysfunction in Parkinsonism

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Introduction:
Speech dysfunction ranges from 75-89% i.e. Parkinson's Disease(PD), Multiple System Atrophy(MSA), and Progressive Supranuclear Palsy (PSP), that may manifest as any or all of the following i.e. respiratory, phonatory, resonatory, or articulatory malfunctioning of the speech production mechanism.
Methods:
The study was conducted on (29 PD, 20 MSA and 19 PSP) subjects on 1.5T Avanto MR Scanner using BOLD imaging with active and baseline phases. Active phase involved audible reading of simple bisyllabic meaningful Hindi words which included the articulation of 5 types of non-nasal stop constants and a nasal consonant. The recorded voice of subjects was acoustically analyzed using spectrogram and correlated to BOLD activation in different brain areas.
Results:
The intensities and voice onset time were affected in these patients; and during nasal consonants, all acoustic parameters were significantly affected. The BOLD activation in the primary motor cortex correlated positively to VOTs and F2 formants to the supplementary motor area.
Conclusion:
The differences in the acoustic quality of various stop consonants patients may be helpful in differential diagnosis in Parkinsonian disorders.

Changing Personalities? Are Behavioural Syndromes Modified During Metamorphosis in the Indian Common Toad?

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The personality traits (behavioural consistency) shown by nonhuman species and their relationship to various ecological and evolutionary processes is currently a subject of great academic interest. The term personality is often used synonymously with temperament, coping strategies or behavioural syndromes. A behavioural syndrome is defined as a suite of correlated behaviours that remain linked to one another across situations. This strong consistency and linkage could conceivably restrict behavioural plasticity, which may often be of great importance in specific ecological contexts wherein the rigidity of a behavioural phenotype could put an individual at considerable risks of survival. It may then not be too far-fetched to speculate that as individuals undergo morphological and anatomical transformations, accompanied by drastic niche shifts, during metamorphosis, certain behavioural correlates that are necessary during particular life-history stages could be subsequently decoupled.

Amphibians provide good model systems to investigate potential changes in behaviour across different ontogenetic stages as they undergo extensive morphological and niche transformations over the course of metamorphosis and are usually subjected to different selection pressures during different stages of development. Despite their great potential as model systems in animal personality research, however, they remain largely under-studied and there has been, till date, only a single study in anurans that reports a consistency in personality over metamorphosis. Our study documentes the modification of behavioural syndromes in the larvae of Duttaphrynus melanostictus, the common Indian toad, across various ontogenetic stages during metamorphosis.

We studied three out of the five major recognised axes of animal personality traits, namely, boldness-shyness, exploration-avoidance and activity (the other two being aggressiveness and sociability), exhibited during the four vital stages of metamorphosis in this species – appearance of hind limb buds (Stage I), fully developed hindlimbs (Stage II), developed forelimbs (Stage III), and juvenile toads (Stage IV) – using an open-field apparatus. All the experiments were videotaped and footage analysis was conducted to quantify variation in different behavioural parameters such as the startle response shown in a novel area, recovery from startling, different components of exploratory behaviour, and reaction to vibration and tactile stimuli.

A significant difference was observed in the performance of behaviours such as the time taken for recovery from startle, exploratory behaviour, and reaction to touch and vibration between Stages I and IV, on one hand and Stages II and III, on the other. The elevated levels of behavioural performance shown during Stages II and III, along with the enhancement of speed and extent of exploration as well a heightened response to vibration and thigmatic stimuli (typically cues announcing danger of predation) could be associated with the increased energy needs of tadpoles undergoing significant restructuring of anatomy and physiology in these developmental stages. In contrast to the other amphibian species studied, the correlated appearance of different personality traits varied across the different stages of metamorphosis in D. melanostictus. The second stage of metamorphosis, for example, appears to be unique, as far as behavioural syndromes are concerned, in this species as the linkages between many behavioural traits observed in other stages of development were not apparent during this phase. The appearance and differential expression of behavioural syndromes thus appear to be crucial in determining the successful adaptation and survival of this toad, particularly as it transforms from a completely aquatic to a terrestrial organism.